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This publication's purpose is to provide assistance in the planning of industrial arts facilities through suggestions and guidelines for functional space utilization and meaningful educational specifications. It is one of a series on specialized areas of the school plant. Chapter headings include "Educational Trends and the Emerging Industrial Arts Program," "Planning the Industrial Arts Program," "Space and Facilities Needed," and "Planning the General Physical Environment." Also included are 28 safety and health precautions, 11 general guidelines, 23 specific guidelines, and 59 references. (EM)

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# Planning and Designing Functional Facilities for INDUSTRIAL ARTS Education

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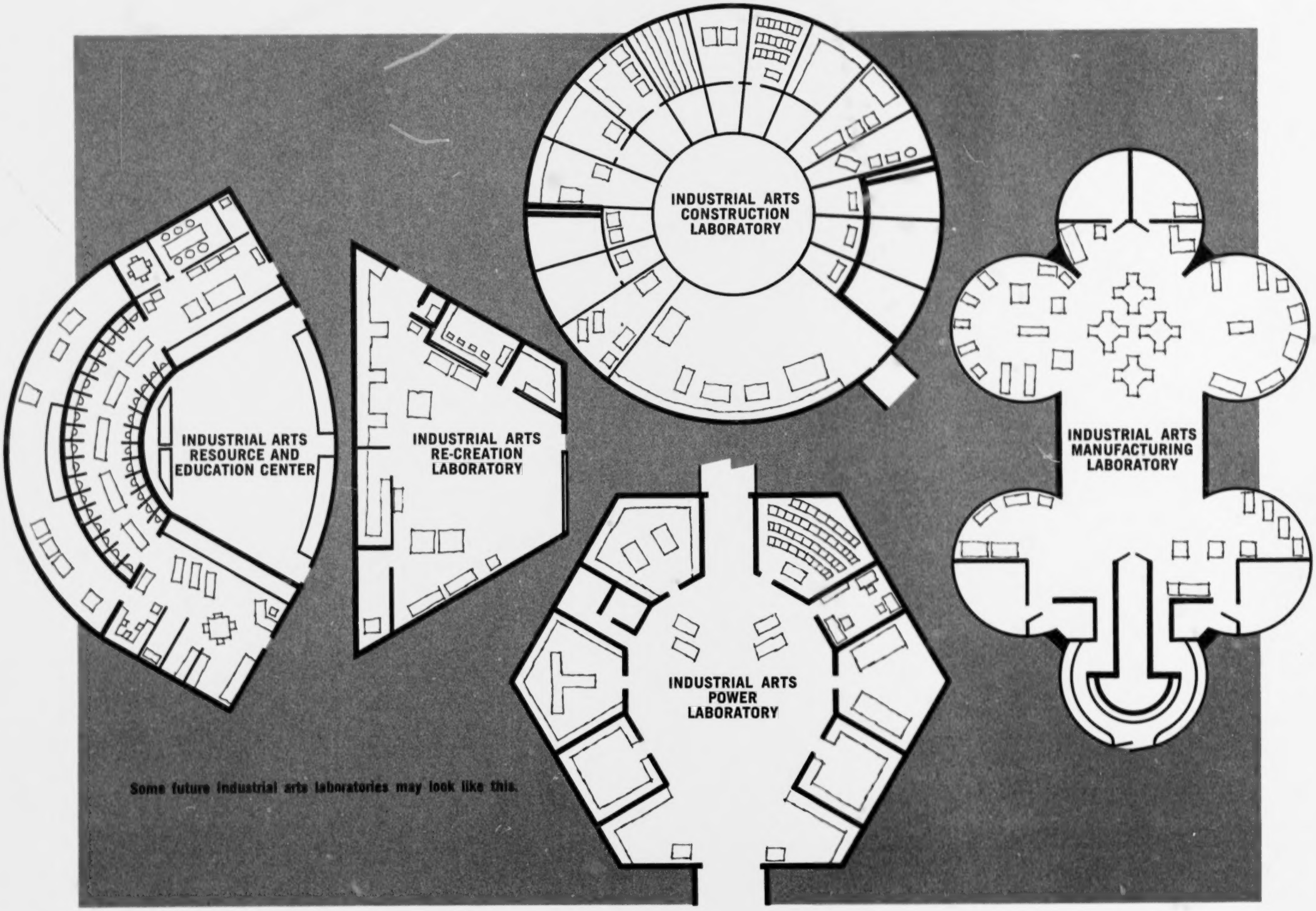


Some future industrial arts laboratories may look like this.

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

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# Planning and Designing Functional Facilities for INDUSTRIAL ARTS Education

OE-51015

by
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and
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U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Wilbur J. Cohen, *Secretary*

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Harold Howe II, *Commissioner*

# FOREWORD

*Industrial Arts Education—Planning and Designing Functional Facilities* is another in the series of publications on specialized areas of the school plant. It seeks to provide assistance in developing new and remodeling existing facilities to meet the expanding programs of industrial arts as they reflect changes in industry and technology.

While no publication will answer all questions, the ideas outlined here will help administrators, school committees, architects, teachers, teacher educators, and supervisors to plan the physical setting for learning and teaching. This publication attempts to present an approach to good planning, not to set standards.

The authors obtained background information for this study from consultations with persons concerned with planning bulletins, from research findings, as well as from visits to and observations of functional programs and facilities in schools in several States. The sketches represent the many useful ideas gathered from these visits.

Special acknowledgment is given to John Mitchell, chairman, Department of Industrial Arts and Technology, Gorham State College, Gorham, Maine, for his advice on the preparation of this publication; Delmar Olson, chairman, Department of Industrial Arts, Kent State University, Kent, Ohio, for new designs in laboratory planning; E. Allen Bame, industrial arts coordinator, for the instructional plan of the Warrensville Heights High School, Cleveland, Ohio; Robert Woodward, supervisor of industrial arts, State Department of Education, Sacramento, Calif.; and Theodore E. Guth, supervisor of industrial arts, State Department of Education, Raleigh, N.C., for selected typical industrial arts plans.

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# CHAPTER I ■ Introduction

THE LARGE SUMS OF MONEY—local, State, and Federal—allocated for school construction throughout the Nation have placed an awesome responsibility on those concerned with the planning of educational facilities. From the outset the school planner is confronted with the problems of increasing school populations, mounting costs of construction and equipment, rapid technological changes which can make equipment and curriculums obsolete, innovations in instructional methods, and increasing emphasis on continuing education. The planning of facilities for industrial arts requires careful attention so that full value for capital and operating investments may be received and maximum achievements realized in an important part of the school curriculum.

Planners must clearly understand an industrial arts education program to be able to design functional facilities. Those educators who will use the facilities must assume a major responsibility in planning. They should interpret the needs to school administrators, school boards, citizen planning committees, and architects so that adequate space and needed facilities may be planned. Coordination in planning is essential if a functional industrial arts department is to be provided.

## Purpose of This Publication

This publication attempts to assist persons planning industrial arts facilities by providing suggestions and guidelines for functional space utilization and meaningful educational specifications. It proposes to illustrate an approach to good planning and to open new vistas to those responsible for making plans, not to set standards. It should be helpful in preservice and inservice education of teachers faced with the challenge of planning facilities. It should provide local school architects a basis for communicating with teachers and supervisors in obtaining pertinent information concerning the program which will reflect in their planning. It should also be of value to those considering remodeling or updating their present facilities.

In preparation for writing this publication, the authors studied and analyzed current industrial arts curriculums and trends in both elementary and secondary education, visited schools in several States, conferred with planning specialists at colleges of education, interviewed teachers and State and local supervisors, examined State planning bulletins, and reviewed pertinent research findings.

The sketches throughout the publication represent an artist's view of facilities actually found in some of the industrial arts laboratories in the Nation's schools and some innovations in industrial arts facilities or architectural design which should provide additional direction to both planners and architects.

## Definition of Terms

The following terms are defined to show their use in this publication:

*Industrial arts*—a phase of the curriculum in general education; the body of subject matter or the body of courses organized to develop an understanding of the technical, consumer, occupational, recreational, organizational, social, historical, and cultural aspects of industry and technology. Student experiences involve such activities as experimenting,

designing, constructing, evaluating, and using tools, materials, and processes which provide opportunities for creativity and problem solving.

*Subject area*—a main division of subject matter; sometimes used as a synonym for *course* (examples: construction, manufacturing, drawing (engineering), electricity/electronics, elementary school industrial arts, graphic arts, home mechanics, metals, plastics, power mechanics, research and development, and woods).

*Instructional area*—a further division or phase of the instructional content in any subject area (examples: lettering, sketching, machine drawing, engineering, and architectural drawing in the subject area of drafting).

*Industrial arts department*—a department planned and equipped to facilitate the teaching of the subject matter of the industrial arts; may consist of one or more separate facilities for the variety of courses taught in a particular school.

*Functional facilities*—the rooms or space which the department occupies; includes equipment, tools, instructional materials, and space provided for storage, individual and group work, and special needs required by the activities being conducted—all effectively arranged to provide for flexibility or adaptability to technological and instructional changes, and for the safety and health of the students.

*Main laboratory space*—the major open space designed to house the principal equipment used primarily to implement the technical aspects of the industrial arts program; area generally free from enclosed partitions and of sufficient size to accommodate the space needs of all students in class.

*Auxiliary space*—additional space used to supplement the main laboratory space and designed to increase the effectiveness of the total facilities and industrial arts program (examples: planning area, teacher's office, finishing room, various storage areas, and dark room); sometimes auxiliary spaces are designed as integral parts of the main laboratory space.

*Comprehensive general laboratory*—one of three types of industrial arts laboratories, a space specifically designed and equipped for several types of instructional activities in two or more subject areas and usually taught by one teacher. A typical laboratory may provide instructional experiences in drawing, metals, woods, and electricity/electronics; or manufacturing, construction, graphics, and electricity/electronics.

*General unit laboratory*—a space designed and equipped for several instructional activities in *two or more instructional areas* of a *single subject area* of industrial arts. A typical laboratory may provide instructional experiences in the metals area and include the closely related instructional areas of machine shop, sheet metal, forging, foundry, bench or art metal work, and welding. Another illustration is a space equipped for several instructional activities in drawing or drafting, involving one or more subjects and learning activities, such as architectural drafting, engineering drawing, industrial design, and descriptive geometry.

*Unit laboratory*—a space designed and equipped for several instructional activities in *one instructional area* of a *single subject area* for industrial arts. A typical laboratory may provide the opportunity for students to have instruction in metal machining—one instructional area of the metals subject area.

Children learn to control their environment through industrial arts activities.

# CHAPTER II ■ Educational Trends and the Emerging Industrial Arts Program

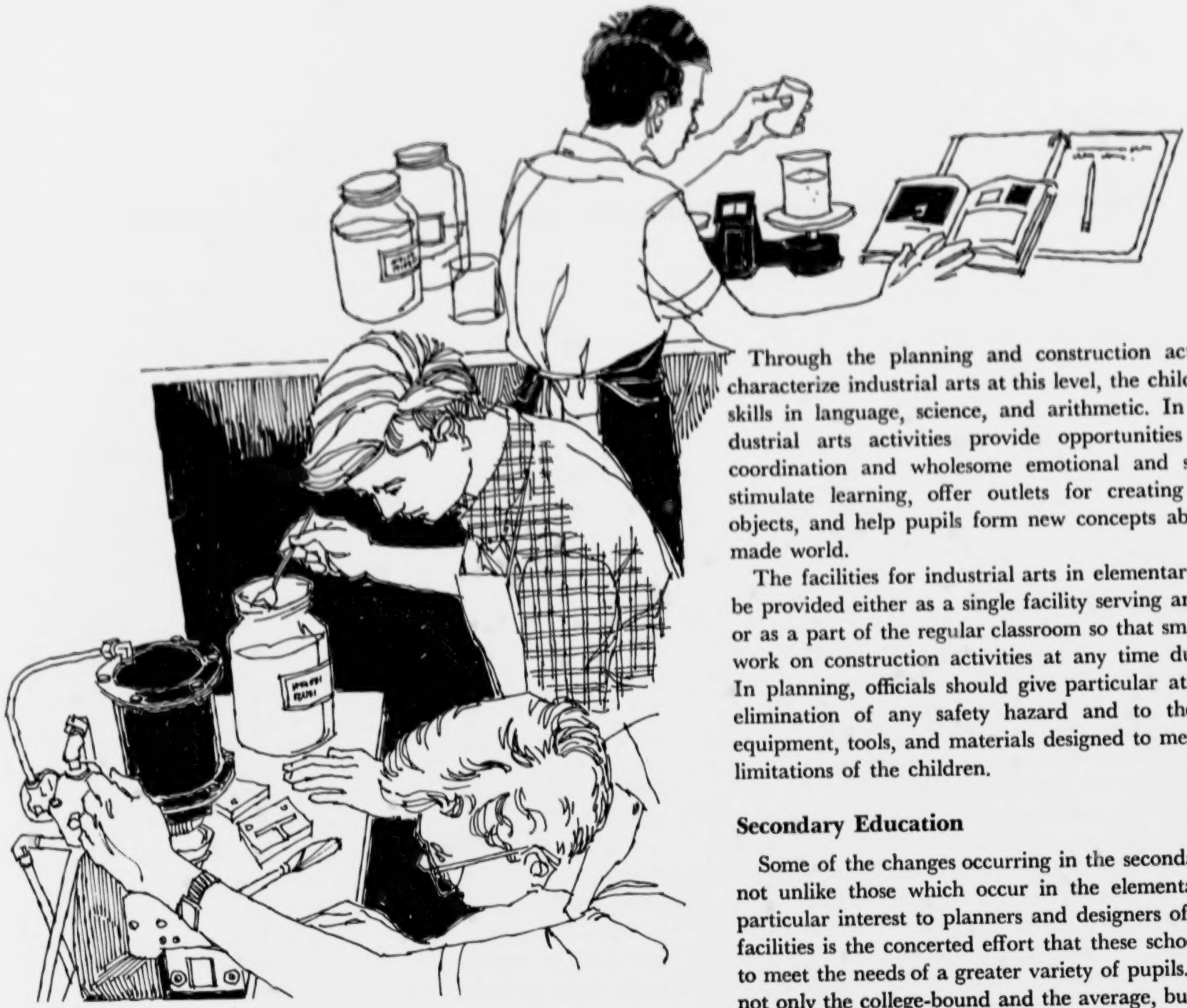
WITHIN RECENT YEARS, scientific and technological achievements and sociological developments have had a profound effect upon the educational community. Changes in curriculums, organizational patterns, and instructional methodology brought on in part by increased enrollments have been reflected not only in the plan for education but also in the physical environment. Industrial arts, as a part of the total program of education, is particularly sensitive to developments in education. A brief review of those developments, at the various levels of education, which have clear implication for industrial arts and its facilities follows.

## Elementary Education

The elementary school has been one of the most flexible units of the school structure. The changes in its external appearance are obvious when one contrasts the old, multistory buildings with the new, one-level structures situated on generous sites that allow for landscaping and play areas. While physical contrasts within the school are startling, of even greater significance are the changes in organizational patterns and instructional methods. Of particular note are the trends toward the elimination of rigid grade divisions and the reorganization of programs to extend over two or more years of a child's growth; an extension of the school day and year to permit certain courses of the curriculum to be fully augmented and newer courses to be added; and an increase in the use of team teaching, closed-circuit television, and other electronic and mechanical devices.

In many instances, the traditional rectangular classroom is being replaced by spaces of various shapes to obtain more effective utilization of space. In some sections of the country, even hexagonal-shaped classrooms are being used to obtain a higher degree of flexibility. Movable soundproof partitions can provide for large and small classes and group work, isolate noise from quiet areas, and permit more effective use of newer instructional technology. Special education rooms designed specifically to meet the needs of the handicapped, adequate libraries with workrooms, and storage facilities for audio-visual equipment are also becoming a part of functionally planned elementary schools.

Since industrial arts subject matter is rich in the material culture, it can capture the young learner's attention and enrich his concepts. From a study of industrial arts, elementary school children can gain new meanings and understandings about the world in which they live, especially the manmade world. Pupils who see only the products of industry have little knowledge of the technological processes involved in their creation and development. Industrial arts education provides the opportunity for pupils to learn about the impact of technology through direct learning activities which are meaningful to them. If properly taught, instruction concerning an ordinary piece of wood, for example, enables the student to learn many meanings of the symbol *wood*—its texture, smell, weight, and taste—and to understand its increased value when he changes it to meet his needs.



Searching for solutions to technological problems.

Through the planning and construction activities which characterize industrial arts at this level, the child increases his skills in language, science, and arithmetic. In addition, industrial arts activities provide opportunities for physical coordination and wholesome emotional and social growth, stimulate learning, offer outlets for creating and making objects, and help pupils form new concepts about the man-made world.

The facilities for industrial arts in elementary schools may be provided either as a single facility serving an entire school or as a part of the regular classroom so that small groups can work on construction activities at any time during the day. In planning, officials should give particular attention to the elimination of any safety hazard and to the selection of equipment, tools, and materials designed to meet the physical limitations of the children.

## Secondary Education

Some of the changes occurring in the secondary schools are not unlike those which occur in the elementary school. Of particular interest to planners and designers of industrial arts facilities is the concerted effort that these schools are making to meet the needs of a greater variety of pupils. These include not only the college-bound and the average, but also the slow, the gifted, the physically or mentally handicapped, and the

culturally deprived. Programs offering pupils opportunities to learn both in class and out of class are being accepted in many schools. Similarly, industrial arts programs with their numerous opportunities for individual and group activities and their concern for pupils whatever their capabilities are increasing in number throughout the Nation.[1,2] For example, girls enrolled in some home economics classes are exchanging places with boys in industrial arts so that both groups may increase their knowledge and understanding of the home, its problems, managements, and maintenance. Through short courses or units, girls learn about industry and technology and their role in it; use common tools and equipment safely; and investigate the purchase, use, and simple servicing of manufactured articles and devices. Boys, on the other hand, learn about home management, food and diets, aesthetic aspects of the home, and, to some degree, preparation of foods, and clothing repair and maintenance.

To meet the needs of pupils in all programs, school officials are using more flexible time segments, longer school days, and a longer school year.

[1] Grace S. Wright. *Offerings and Enrollments in High School Subjects.* Washington: U.S. Government Printing Office, 1960.

[2] Marshall L. Schmitt and Albert L. Pelley. *Industrial Arts Education, A Survey of Programs, Teachers, Students, and Curriculum.* Washington: U. S. Government Printing Office, 1966.

Industrial arts experiences help individuals buy and use industrial products wisely.

Learning about industrial arts—technology—is a lifelong process.

## Continuing Education

The concept of continuing education, starting with early childhood and persisting throughout life, is being accepted by many communities. The rapid rate at which knowledge and jobs become obsolescent, and the fact that problems of living take on different connotations and require different solutions through the various cycles of life have convinced them that education completed yesterday is inadequate for today. Such communities are challenging their schools to provide for all who would continue their education and for the dropouts who, in order to secure a job or make a living, must return to school for more and perhaps a different kind of education. The school is being challenged to provide adequate space and appropriate facilities for all who would continue their education throughout life.

As adults and youth return to school in increasing numbers, special provisions will be needed for space and equipment. Some of the same facilities used by high school pupils may be used by adult classes. The more classes scheduled for space, however, the more storage will be needed for supplies and materials used by these groups.

## Changing Procedures and Materials

Changing instructional procedures and materials are also influencing school planning. For example, educational television, teaching machines, programed learning, and computer-assisted instruction are being used in teaching industrial arts. Small television cameras and associated electronics equipment make it possible for industrial arts teachers to videotape industrial processes and to correlate them with classroom instruction. Conference techniques call for tables and chairs to be moved from place to place to facilitate instruction. Space and facilities for these innovations must be considered in future planning.

Pupils are being given more opportunity to spend part of their time studying independently and are being provided private space, such as carrels, either in the library or in designated areas nearby. Tape recorders or other teaching aids and materials are readily available and encourage individual study.

Provisions are also being made for space which can house large classes of a hundred or more students, but which can be divided into smaller units of three to five rooms. The flexibility of this arrangement provides for team teaching and the improved use of many types of instructional media. Both equipment (television and programed learning devices and machines) and audiovisual instructional materials (overhead, opaque, motion, and still projectuals) are being used effectively in schools.

## Current Developments in Industrial Arts

Physical facilities for teaching industrial arts are influenced not only by trends which affect all education but also by changes which are occurring in the subject field itself. Below are some of the more evident developments and their implications for planning facilities.

*Change in Objectives.*—The spectacular technological changes since World War II have had a significant impact on all education including industrial arts. Because the organization of any course—its content, method of teaching, and evaluation—is based upon objectives, industrial arts educators have examined those which have guided the program for many years. They noted that the objectives which were the hallmark of industrial arts after the turn of the century were not applicable to today's space era. In an attempt to delineate those which are "unique, attainable, and likely to achieve the desired results," Hostetler,[3] reports the following objectives

[3] Ivan J. Hostetler. "What Objectives Should Be Emphasized in Industrial Arts," *Improving Industrial Arts Teaching.* Washington: U.S. Government Printing Office, 1962, pp. 11–28.

which should be emphasized in public school programs:

1. To develop in each student an insight and understanding of industry and its place in our culture.
2. To discover and develop talents of students in the technical fields and applied sciences.
3. To develop technical problem-solving skills related to materials and processes.
4. To develop in each student a measure of skill in the use of common tools and machines.

These four, with minor variations, have been generally accepted by the profession and are being emphasized increasingly. Specific objectives for the various age and grade levels from elementary through senior high school, modified for the slow learner as well as the gifted, must of course supplement the basic objectives.

To implement these objectives the industrial arts department should include functional facilities for as many subject areas as feasible within the budgetary limitations. These should be designed and planned to meet the needs of each pupil, and should have "built-in" flexibility and adaptability for future changes in technology and industry.

*The Expanding Curriculum.*—Curriculums which carry out the objectives of industrial arts have in recent years been the subject of extensive study by national and State professional organizations, departments of education, college and university research teams, as well as leaders in the field. Some of the investigations are still in process, while others have been completed and reported. Of special interest to planners of industrial arts facilities is the goal of all these investigations—namely, how best to provide a program which will prepare pupils at the various grade and age levels and those with different educational capacities and motivations for the technological culture. Any curriculum, however devised, will be subject to State and local community determinants which should be thoroughly explored before serious planning begins.

A brief review of curriculum developments about which there seems to be consensus may provide the planner initial direction. At the junior high school level—grades 7, 8, and 9—several subject areas are being added to the curriculum, either separately—as drawing or drafting, woods, metals, electricity and electronics—or integrated, as manufacturing or construction. These give pupils an opportunity to learn about and explore the many facets of these industries and to help them discover and develop whatever technological talents they may possess. The types of industrial arts laboratories suitable for the junior high school program are the *comprehensive general* and the *general unit*. (See p. 17 for a discussion of the various types of laboratories.) The former is preferred, although it requires specially prepared teachers. Where the latter is found, one facility for each subject area is usually provided. These are more expensive to equip, but larger school systems find them better suited to their needs.

At the senior high school level—grades 10, 11, and 12—the curriculum provides for greater concentration in one or more subject areas which are only touched on at the lower level. Laboratories for high school programs are of the *general unit* and, in some larger schools, the *unit* type. Some schools use two or more comprehensive general industrial arts laboratories, but usually offer only two subject areas; these are closely associated, such as woods and metals, power mechanics and electricity/electronics, or graphic arts and drafting.

An approach to curriculum development which is currently receiving the attention of the profession is that outlined in the publication *Industrial Arts and Technology* by Delmar W. Olson of Kent State University.[4] The curriculum for industrial arts which this text presents reflects the technology beginning in the elementary school and extending through the university. His recommended curriculum for both the ele-

[4] Delmar W. Olson. *Industrial Arts and Technology*. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1963.

mentary and the secondary schools as outlined in a U.S. Office of Education conference report [5] is:

*Elementary School*

Grades 1, 2: Technology and the Community
Grades 3, 4: Technology and the Nation
Grades 5, 6: Technology and the World

*Junior High School*

Grade 7: The Manufacturing Industries: Leather, plastics, ceramics, chemicals, food
Grade 8: The Manufacturing Industries: Graphic arts, paper, textbooks, rubber
Grade 9: The Manufacturing Industries: Metals, woods, tools, machines

*Senior High School*

Grade 10: The Construction Industries
The Electronic Industries
Grade 11: The Power Industries
The Transportation Industries
Grade 12: The Service Industries
Industrial Management
Grades 10, 11, 12: Research and Development
Grades 10, 11, 12: Industrial Arts Recreation

The challenge of Olson's research has been accepted by some industrial arts educators, among them officials of Maine's State Department of Education. The department has prepared a State curriculum guide;[6] revised its teacher education curriculum, including designing and constructing functional facilities; and is currently using the new curriculum in several schools. New and remodeled laboratories at both the junior and the senior high school levels are of the comprehensive general type designed to provide experiences which encompass most of the subject areas outlined by Olson.

Other research studies hold promise for industrial arts curriculum development. For example, the research at the State University of New York at Oswego, New York, entitled "Field Study in Industry for the Preparation of Industrial Arts Majors" is expected to identify many of the basic concepts of industry.[7] At the University of Minnesota, Minneapolis, a project is investigating two methods of teaching the theory and practice of the plastics industry.[8]

Another research study, entitled "An Industrial Arts Curriculum Project for the Junior High School" conducted at Ohio State University, Columbus, Ohio, is developing a rationale and structure for industrial arts subject matter.[9] These and other research studies will no doubt influence industrial arts instruction.

The evaluation of achievement in industrial arts will also affect curriculum direction and, indirectly, facilities planning. Until recently standardized tests had not been developed for industrial arts, hence comparative data on the effectiveness of instruction and content were lacking.[10] Studies producing such data would have a strong influence on the type and quality of the education provided.

[5] ——, "What Guidelines Should Be Followed in Determining Curriculum Content for Industrial Arts?" *Improving Industrial Arts Teaching*. Washington: U.S. Government Printing Office, 1962, pp. 23-24.

[6] *Industrial Arts Technology: A Study of American Industry*. Augusta, Maine: State Department of Education, 1965.

[7] *Field Study in Industry for the Preparation of Industrial Arts Teachers*, State University College, Oswego, N. Y. Final report, Project 5-1369, Contract OE-6-10-128, Vol. I. U.S. Department of Health, Education, and Welfare, August 1967.

[8] *A Comparison of Two Methods of Teaching Concepts About the Plastic Industry for Industrial Arts Education*, University of Minnesota. Project No. 6-8022, Contract No. OE-6-10-351. U.S. Department of Health, Education, and Welfare, April 1967.

[9] *An Industrial Arts Curriculum Project for the Junior High School*, Ohio State University, Columbus, Ohio. BR 5-0059, OE-585-066. U.S. Department of Health, Education, and Welfare.

[10] *Educational Testing Service: Series of Standardized Industrial Arts Achievement Tests*. Princeton, N. J. In Press.

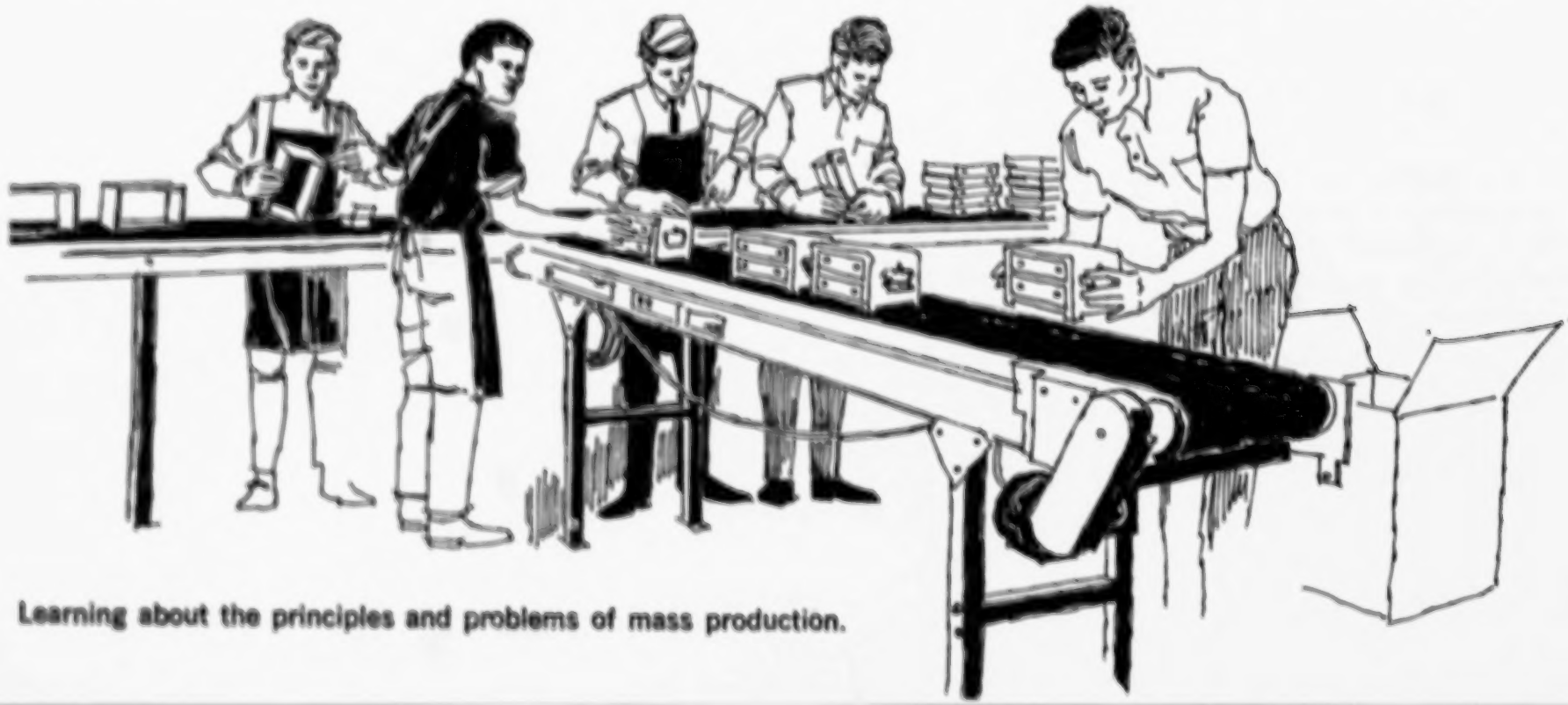
*Instructional Practices.*—Class instruction and individual instruction are used by industrial arts teachers. Supplemented by the usual audiovisual aids and devices—films, slides, models, mockups, opaques, tapes—and newer instructional media—television, teaching machines, overhead projectuals, and single concept films, such instruction becomes increasingly more effective. However, as the curriculum expands to reflect in greater degree the advancing technology, industrial arts teachers find it more difficult to stay abreast of all new developments. Hence, attention is being directed toward team teaching, which will not only increase teacher efficiency in handling different groups of pupils but also permit each teacher to upgrade and maintain his technical understanding and skills and his professional education competencies.

Two other instructional practices which may affect planning are research and experimentation and mass or line production.

*Research and experimentation* involves the more advanced pupils in problem-solving activities which typify those confronting scientists and engineers in industry. The problems, which are usually centered in industrial materials or processes, are solved by using the scientific method of inquiry. Experimental apparatus is used or devised to arrive at or test solutions to the problems. If science laboratories are near the industrial arts laboratories, the need for some special facilities will be minimized.

*Mass or line production,* which involves the pupils in manufacturing a product in quantity for a charitable organization, for sale, or for themselves, is one of the most effective means by which teachers develop student understanding of the functions of production industries. Such experiences reach pupils of all levels of aptitude and interest, from the lowest to the highest, each finding a place in which he can participate successfully. Any industrial arts facility may be used in this method; however, in order to simulate a production line, it is often necessary to move and rearrange equipment.

The planning of industrial arts facilities can be complicated by evolving curriculums, State and local determinants, and unusual instructional methods. Planning, therefore, must provide for flexibility and adaptability to innovation and change.



Learning about the principles and problems of mass production.

# CHAPTER III ■ Planning the Industrial Arts Program

## The Planning Committee

THE PLANNING OF INDUSTRIAL ARTS FACILITIES should involve individuals and groups who, because of their background and experience, can make valuable suggestions. Similarly, by utilizing all available resources in the community, a school will not only meet community needs but also gain the support and confidence of the people in its building program. The following individuals or groups can significantly contribute to and should participate on the planning committee or assist as consultants or resource persons:

- The industrial arts teaching staff who understands the curriculum, the objectives to be achieved, the methods to be used, the kinds of activities to be undertaken, the organization and management of the program, and the relationship of the program to the community and its needs.
- Local school administrators who are concerned for the overall educational program, the goals of the school, and the relationships between all subject fields.
- Local school board members who are aware of the long-range needs of the community, the financial arrangements to be made, and the attitude of the community toward the building program.
- Local or State supervisors of industrial arts who have taught and who know the types of facilities around the State which meet the objectives of the industrial arts.
- Representatives from the State department on school plants and facilities who know the State's regulations—architectural, legal, and educational—and have wide experience with school building problems, needs, and possibilities.
- Representatives from equipment manufacturers who understand requirements and specifications of plans, who can advise on availability and delivery of necessary equipment.
- Outstanding pupils who may have used laboratory facilities and are aware of needs that encourage pupils to strive to meet program objectives.
- A building engineer who understands heating, lighting, ventilation, plumbing, and other facilities that make the building safe and functional.
- A professional architect who has the imagination and skill to incorporate the ideas of others into the design for an attractive and functional building or facilities which will not only meet the educational needs of the community today but also reflect its aspirations for the future.

## Planning Procedures

After a planning committee has been appointed, usually by the local school administrators, procedural arrangements are

established and target dates assigned for completion of the following planning stages:

1. Securing and reviewing literature on the industrial arts program in elementary and secondary schools featuring materials on planning.
2. Reviewing pertinent data from completed long-range school and community surveys, such as population changes, community characteristics, apparent interest in industrial arts, and status of facilities.
3. Visiting new or remodeled schools in comparable communities having new facilities for industrial arts to collect reliable data but not necessarily to copy plans.
4. Summarizing the data collected and deciding on specific facilities to meet the needs for the industrial arts instructional program.
5. Preparing the educational specifications for approval of the administrators and/or the school board, and for submission to the architect.

The preparation of educational specifications is perhaps the most important function of the planning committee. These specifications convey to the administrator and the architect what should be specifically considered in planning the department and its facilities. They should be written and presented in such a manner as to leave little or no doubt about what is expected. Floor plans and sketches or other illustrations of special facilities may also be provided.

Educational specifications for the industrial arts department should include: (1) the philosophy and objectives of the school and program; (2) the number and characteristics of the pupils to be served; (3) the program of studies, including courses to be offered, teaching methods, and materials; (4) facilities and services needed, such as storage, planning area, power and lighting, ventilation and fume exhausts, thermal and air conditioning, floors and floor coverings, plumbing for air, gas, water, and drains; and sound and color conditioning; (5) space requirements and floor plans; and (6) equipment, materials, and supplies.

The scope and quality of these specifications will be reflected in the design and plans prepared by the architect who must have a clear picture of the total program. It may be advantageous to have an architect who is unfamiliar with modern industrial arts programs visit and observe some classes so that he may relate some of the specifications to actual practice. This will not only improve his understanding of the program but may also suggest other possibilities for using space, designing facilities that fit specific needs, and placing equipment.

Cooperation between the planning committee, the architect, the administrator, and the community is essential to the successful implementation of building or remodeling plans. The architect's interpretations of the needs indicated in the educational specifications should be reviewed by the superintendent, the planning committee, and school board. The original plans may have to be changed to meet financial limitations; to adapt the facilities to a more favorable location; to adjust to the demands of other departments; or, in the case of remodeled facilities, to overcome obstacles not previously envisioned. However, the planning committee should be given an opportunity to help determine which adjustments can be made. Creative architects will be alert to possible means of meeting requirements with the funds available.

The role of the planning committee does not end with the approval of the building plans. The committee must develop scaled floor plans; locate all equipment and safe working areas to provide for the flow of materials and the safety of teachers and pupils, and locate special facilities such as floor drains, hoods, services, ventilation, and exhausts. It must be ready to provide information or approval needed by the archi-

tect as the building is constructed. Last-minute changes resulting from manufacturing delays or cancellations may call for consultative action. Where possible the committee should observe the building at various stages of construction and call the architect's attention to any discrepancies or changes from the specifications. Finally, after the building has been completed and readied for occupancy, the committee should evaluate the facilities with reference to its planning, the design, and the construction.

## Pupils and Other Groups Using the Facilities[1]

A wide range of individuals and groups may be served by the industrial arts program. The potential groups, together with their characteristics and needs, should be considered insofar as possible when planning and equipping the department.

*Elementary School Pupils.*—In communities where industrial arts is included in the elementary schools, pupils are taught to understand the manmade environment through industrial arts activities in which they modify materials to increase their value in meeting human needs. Consultants from either the junior or senior high school, or supervisors, may assist the elementary school teachers in planning, developing, and enriching units or activities which can help to develop the pupils' understanding and appreciation of our industrial society.

Whether the facilities provided for industrial arts are part of the regular classroom or separate, the physical, emotional, and intellectual characteristics of the children must be considered. Flexibility in the arrangement of equipment and space; storage for equipment, tools, materials, and pupils' work; and equipment scaled to the physical limitations of the pupils are essential. Hand-eye coordination, at this level particularly, should also influence the selection of equipment and tools. The following should be considered carefully.

* Elementary school tool panels, storage areas (cabinets and drawers) and work surfaces (benches) should be designed for easy access and for the height of the pupils using them.
* Portable tool panels should be economical, attractive, sturdy and conserve classroom space.
* Sharp-edged tools should be arranged in tool holders which enclose the cutting edge.
* Color coding of tools is recommended.

*Junior High School Pupils.*—In many communities the junior high school represents the level at which most boys take industrial arts. (Often girls are also enrolled for short units or courses.) For many boys this will be the only opportunity they will have to take industrial arts; therefore, facilities should be provided at this level for teaching a wide variety of courses. Some characteristics of this age group that will influence space and equipment requirements are:

* Junior high school youths vary a great deal in height; and some variation in height of such equipment as benches, storage racks, and tool cabinets should be provided.
* Junior high school pupils, particularly in the seventh and eighth grades, are usually very energetic, like to experiment, and prefer laboratory experiences to observations of others at work. Since they find it difficult to concentrate during long discussion periods, equipment should be planned for full participation of the total group in all laboratory work.
* Pupils of this age group move about freely, and their activities are more easily supervised and regulated if conditions are spacious rather than crowded.

[1] Adapted from James L. Taylor and Johnie Christian, *Planning Functional Facilities for Home Economics Education*. Washington: U.S. Government Printing Office, 1965, pp. 12–16.

* Their interest in and natural desire for mechanical expression and for finding out about the world into which they are being inducted require a wide variety of equipment and activities.

*Senior High School Pupils.*—These pupils are approaching adulthood and take industrial arts because of their interest in gaining additional information and experience in one or more specific subject areas or because of choosing a profession to pursue later in greater depth for employment. Some characteristics of this age group are:

* Although they are interested in abstract thinking and can concentrate on a problem for a longer period of time than before, they still enjoy activity. Space and equipment are needed that will encourage them to test their ideas and develop their judgment.

* They are concerned with personal appearance, friendships, future careers, and other personal problems. Materials and equipment to meet these needs are essential.

* They are approaching adult levels in physical and mental growth. While their behavior may not always be adult-like, they expect responses, opportunities, and freedom that would be accorded adults. Teaching facilities and activities should provide for independent as well as group participation where mature judgments can be developed.

*Industrial Arts Club.*—Youth organizations are playing an increasingly important role in all phases of education. Industrial arts clubs, promoted either locally or by one of the national associations, are becoming an integral part of the program and should be considered in planning. Some of their needs are:

* Space for general meetings and for small group discussions and activities. The laboratory planning center may be used for the latter.

* Space for officers and advisers to plan activities and programs. The planning center may be used for this purpose as well.

* Storage space for activities or projects in which the members are involved, club records, old paraphernalia, and displays.

*Handicapped Pupils.*—Special facilities are usually required to permit these pupils to participate along with their classmates. Portable and/or adjustable equipment should be considered with added emphasis upon safety factors. The resourceful teacher can make the necessary adjustments to meet specific needs or can recognize alternatives, particularly where hazards are present or imminent.

*Adults and Out-of-School Youth.*—The use of school buildings as community centers after school hours is a common practice. The industrial arts department may be used in the evening by out-of-school youths and adults to improve their recreational or hobby skills, learn simple servicing techniques for maintaining or repairing products in and around the home, or, in some instances, develop certain skills useful in their employment, although this is not the intent of the program. Planning for such uses requires careful consideration of entrances and exits which can be used and controlled without access to other parts of the building; additional and/or separate storage facilities for the products or activities of the evening program, particularly if different instructors are employed; toilet facilities for both men and women within or near the laboratory; mobility of equipment to meet the needs of the activities; and localized lighting for close work.

# CHAPTER IV ■ Space and Facilities Needed

FUNCTIONALLY PLANNED SPACE AND FACILITIES FOR INDUSTRIAL ARTS not only assist the instructor in implementing his program but also motivate the pupils by providing an environment and atmosphere that encourage learning. How available space is utilized contributes to the educational usefulness of the facilities.

One of the most pressing problems faced by planners of industrial arts facilities is the provision for flexibility. The evolving curriculum; instructional practices and emphases for different grade and ability levels; technological changes in materials, processes, and equipment; fluctuations in enrollment; needs of special groups to be served; and increased utilization of the facilities are some of the important considerations. The provision of facilities and space that can be adjusted, rearranged, and altered as the need arises is the key to flexibility. The many suggestions in chapter III provide planners with some direction in designing for this goal.

Space for industrial arts education is usually of two types—main laboratory space and auxiliary space.

The main laboratory space is the open area designed to house the principal equipment. It is of sufficient size to accommodate the needs of all the students in the class.

Auxiliary space is any additional area designed to supplement and increase the effectiveness of the main laboratory space, such as the departmental library and planning area, the teacher's office, storage space, finishing room, and darkroom. Sometimes the spaces usually designated as auxiliary space are designed as an integral part of the main laboratory space. The planning area and teacher's office are often found in this way. Whether or not the main laboratory arrangement and the auxiliary spaces are combined is a matter of individual choice, but the functions each performs are important to the smooth operation of the department and should be considered. Various types of space are discussed below.

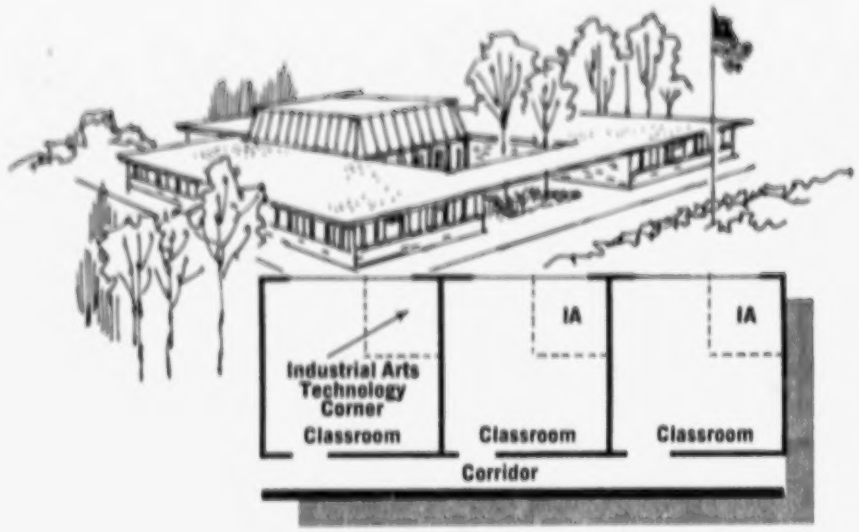
## Laboratories

*Number and Types.*—The number and types of laboratories which a particular school should have depend upon several factors, such as the scope of the industrial arts curriculum, the grade levels, and the school enrollment. In a study of industrial arts education in the United States, Schmitt and Pelley [1] reported that 73.9 percent of all the schools sampled had industrial arts programs, and that the average number of laboratories ranged from 1 in schools with enrollments up to 300 pupils to 7 in schools of 2,500 or more pupils. Data collected at the time of the survey revealed that in the public schools 68.5 percent offered general industrial arts; 63.2 percent, general woods; 63.9 percent, drafting; 41.4 percent, general metals; 17.9 percent, electricity/electronics; 16.2 percent, crafts; 12.4 percent, graphic arts; 10.6 percent, power mechanics; and 5.1 percent for all other courses.

The type of school seems to have an effect on the type of industrial arts courses offered. For example, 82.4 percent of

[1] Marshall L. Schmitt and Albert L. Pelley, *Industrial Arts Education: A Survey of Programs, Teachers, Students, and Curriculum*. Washington: U.S. Government Printing Office, 1966. 148 p.

**ELEMENTARY**

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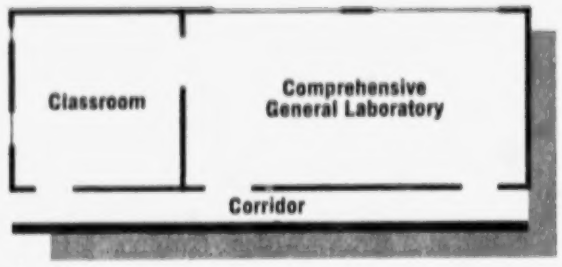
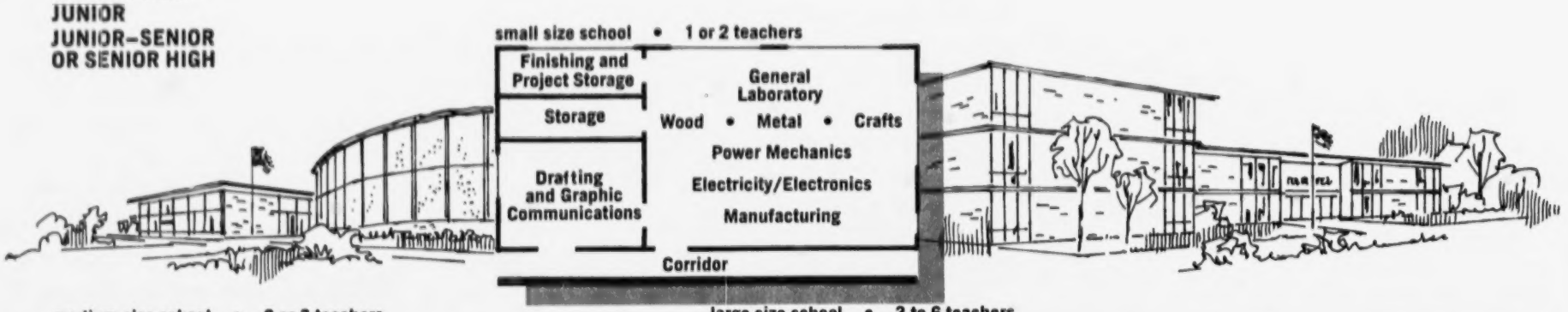
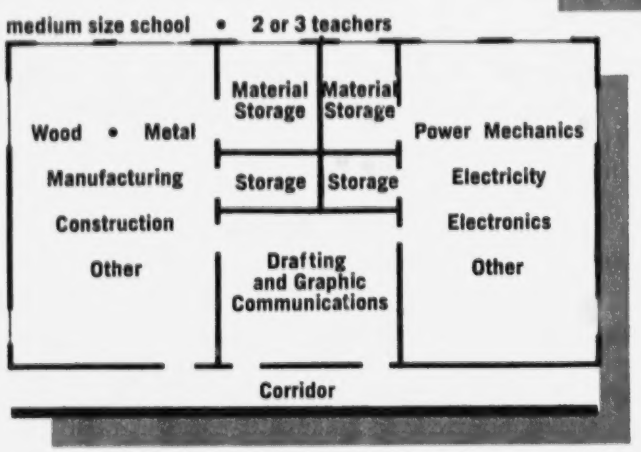
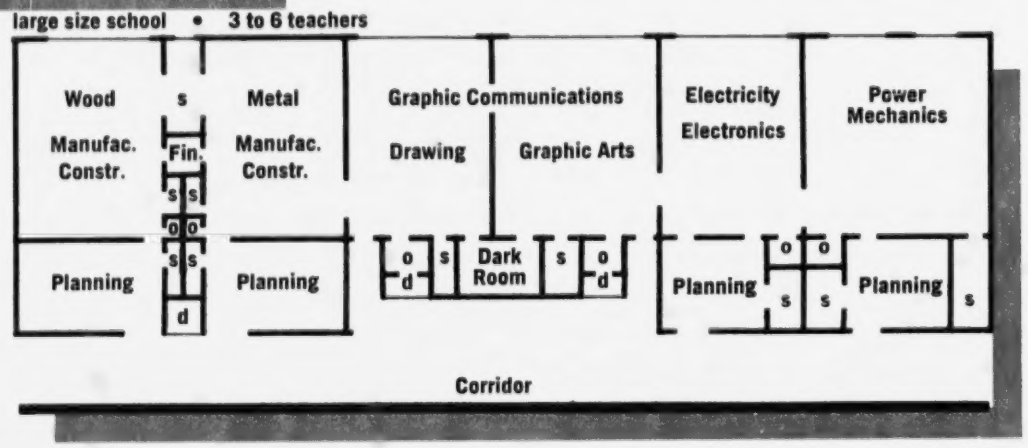



**INTERMEDIATE**
**JUNIOR**
**JUNIOR–SENIOR**
**OR SENIOR HIGH**




s—Storage d—Display o—Office

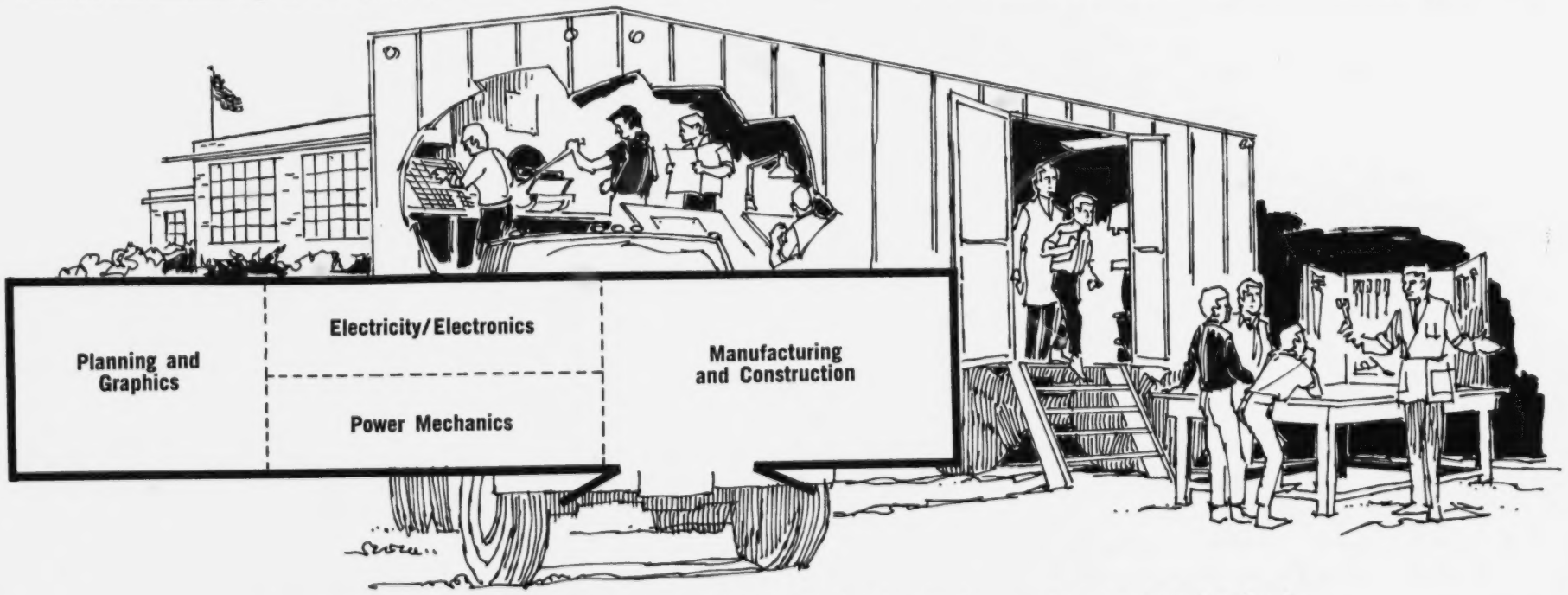


Industrial arts programs and facilities change in relation to the size and type of school.

the junior-senior high schools offered general industrial arts, whereas 50.1 percent offered it in the senior high school. A total of 44.0 percent of the junior high schools offered drafting, whereas 91.0 percent of the senior high schools offered it. All other courses except for general industrial arts and crafts, were offered more frequently at the senior high than at the junior high school level. The average class enrollment in industrial arts was 19.3; the average number of classes taught in all schools was five.

Three types of industrial arts laboratories—comprehensive general, general unit, and unit—are found in schools throughout the country. At the junior high school level, where a broad orientation to all subject areas is considered essential, one or more comprehensive general laboratories are used, depending upon the total school enrollment. In a small school, with an enrollment up to 300 pupils, one such laboratory may provide for many subject areas at the various grade levels; that is, woods, metals, power mechanics, electricity/electronics, drafting, and graphic arts. In very small schools located in remote areas, mobile vans or transportable units equipped with industrial arts facilities are sometimes used. One van may serve several schools on a regularly scheduled basis.

In a larger school with an enrollment up to 750, two or three comprehensive general laboratories may be used, each serving several related subject areas at the different grade levels. Drafting as a subject area is often included with any or all combinations of subject areas. In schools with over 750 pupils enrolled, three or more comprehensive general industrial arts laboratories may be used, with instruction limited to not more than two related subject areas; for example, woods and metals, drafting and graphic arts, power mechanics and electricity/electronics. In schools with enrollments over 1,500, pupils have




Mobile vans or transportable units bring industrial arts to smaller, isolated schools.

opportunities to select instruction from four to six general unit laboratories, each providing instruction in several phases of a single industrial arts subject area, such as general woods, general metals, graphic arts, electricity/electronics, or transportation.

At the high school level, a small school may have a comprehensive general laboratory, especially where no junior high school program is offered. Most if not all of the subject areas are included and taught at the different grade levels. This type of laboratory may also be used in the larger high school to orient to the program pupils who have had no previous industrial arts instruction. In schools with an enrollment of 2,000 pupils, several unit laboratories may be provided, especially at the upper-grade levels, to help pupils gain a deeper understanding of the subject matter. Community needs, however, should dictate the feasibility of including unit-type facilities in the high school because of the costs.

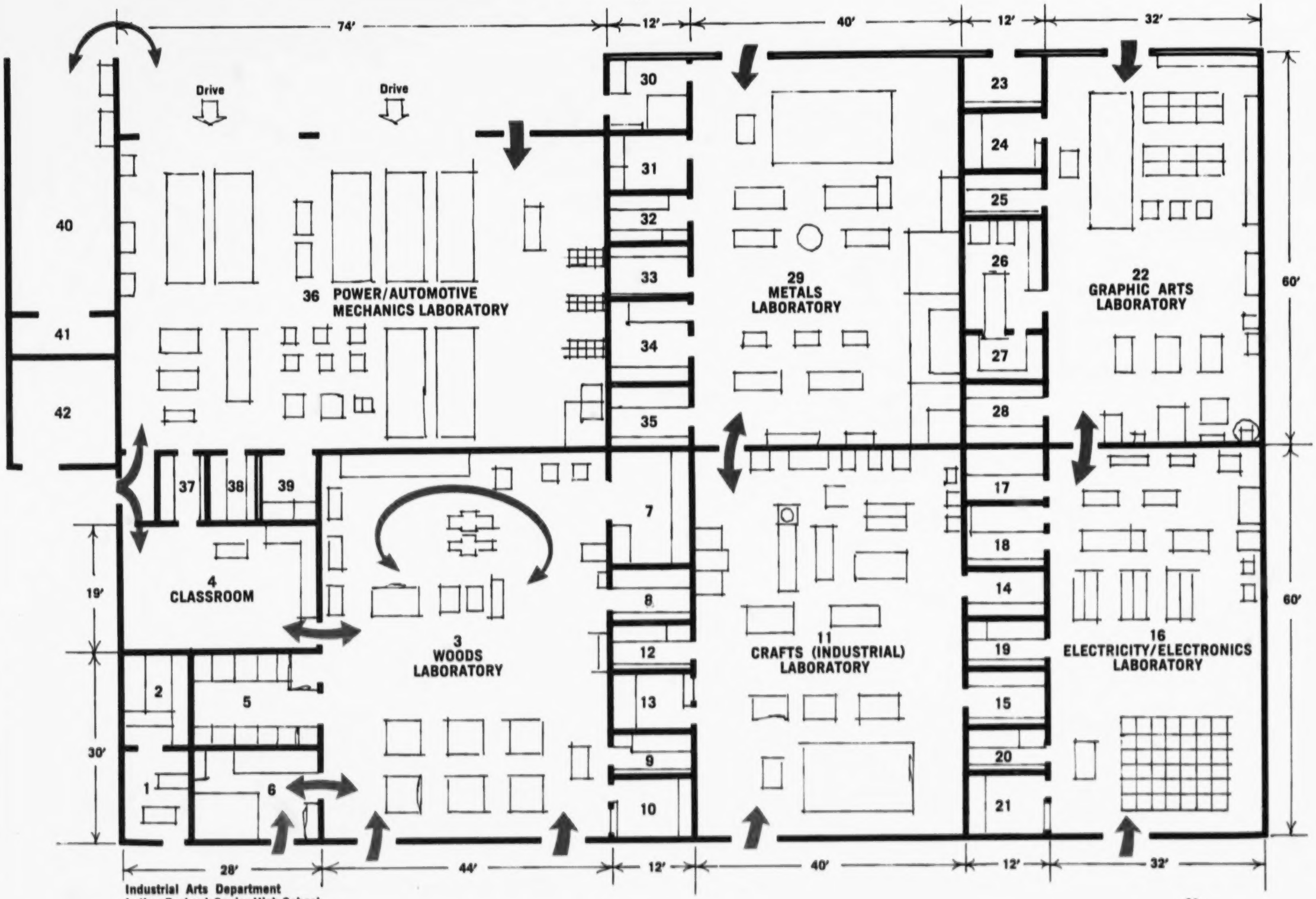
The planner should be concerned with two aspects of laboratory arrangement: the external relationship between laboratories, whenever there are several, and the internal arrangements of facilities and equipment required by the subject area.

*External Arrangement.*—When facilities for two or more different subject areas are planned, the relationships between areas must be carefully considered so that maximum learning and use of facilities will be assured. For example, because of their similarity of functions, the woods, metals, and construction laboratories may share storage, finishing, and planning facilities. Other subject areas which have many similar functions are: electricity/electronics and power mechanics; and graphic arts, drafting, and planning. Another advantage of arranging laboratories according to their functional relationships is the greater flexibility which may be achieved.

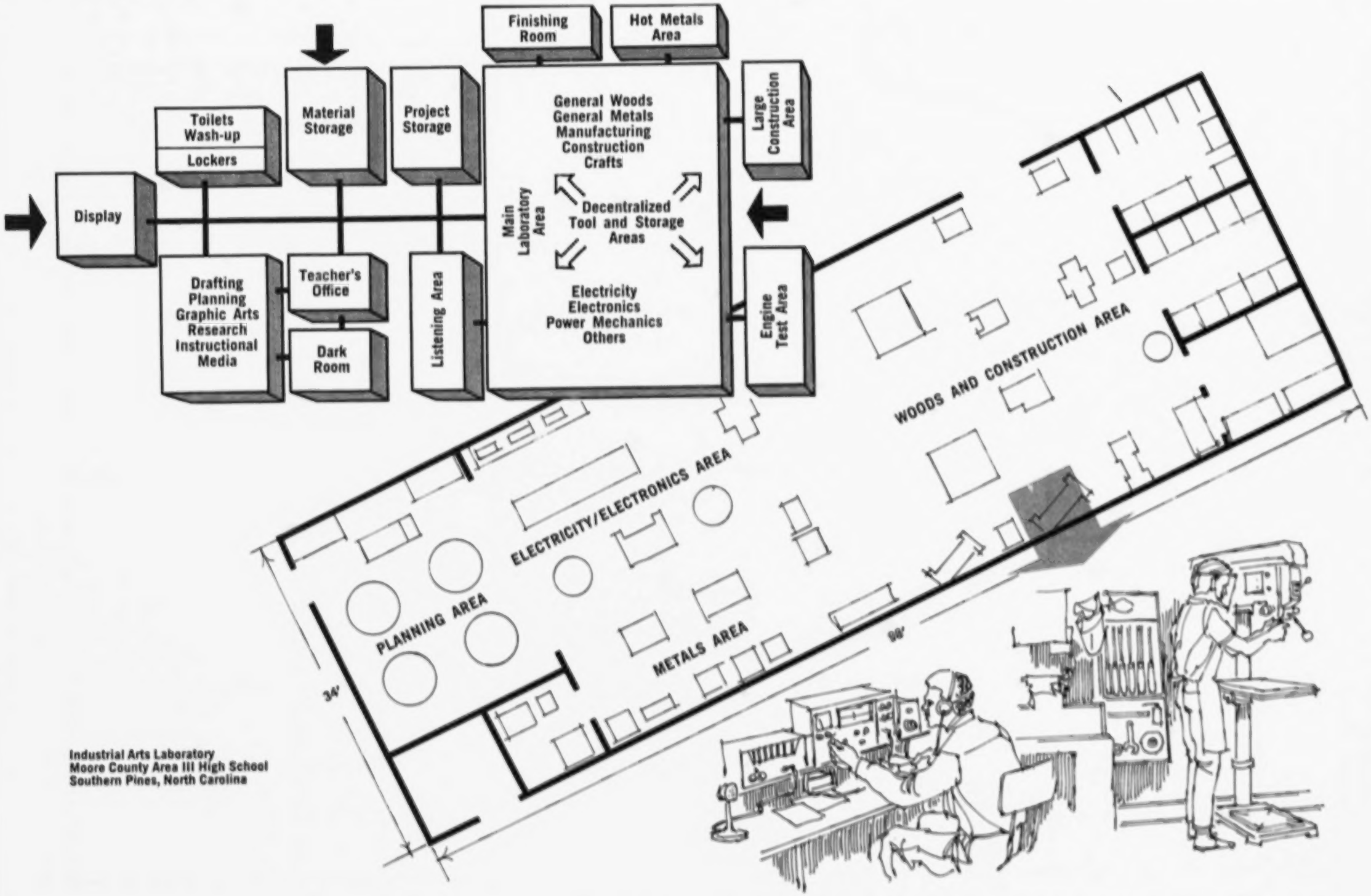
*Internal Arrangement.*—Arrangements within a laboratory depend upon its type and the subject area for which equip-

1—Department Office
2—Department Storage
3—Woods Laboratory
4—Classroom
5—Lumber Storage
6—Finishing Room
7—Project Storage
8—Night Class (Adult) Storage
9—Supply Room
10—Planning Room
11—Crafts (Industrial) Laboratory
12—Supply Room
13—Planning Room
14—Night Class (Adult) Storage
15—Project Storage
16—Electricity/Electronics Laboratory
17—Radio (Amateur) Transmitter Room
18—Project Storage
19—Electronic Test Equipment Storage
20—Supply Room
21—Planning Room
22—Graphic Arts Laboratory
23—Janitor Room
24—Planning Room
25—Supply Room
26—Photographic Laboratory
27—Dark Room
28—Paper Storage
29—Metals Laboratory
30—Finishing Room
31—Planning Room
32—Supply Room
33—Metal Storage
34—Project Storage
35—Night Class (Adult) Storage
36—Power/Automotive Mechanics Laboratory
37—Teaching Aid Storage
38—Supply Room
39—Planning Room
40—Car Wash
41—Storage
42—Gas Meter Space

Proper laboratory arrangement reduces traffic flow, encourages correlated instruction, and conserves space.




Industrial Arts Department
Luther Burbank Senior High School
Sacramento City Unified School District
Sacramento, California




Industrial Arts Laboratory
Moore County Area III High School
Southern Pines, North Carolina

Many elements and their relationships should be considered in arranging the location of instructional areas, regardless of their number.

ment and facilities have been provided. The requirements of a comprehensive general laboratory pose many challenges for both planners and teachers. Subject areas and their instructional areas vary widely. In some schools, related instructional activities—such as planning and design, research and development, and foundry and forge or hot metal activities—are arranged in specific locations in the laboratory to reduce unnecessary traffic flow. Within these locations are found appropriate benches, storage cabinets, tools, machines, materials, reference books, pictures, charts, and project displays. This arrangement, called an *instructional activities center,* can, if well planned and designed, provide an atmosphere to stimulate pupils to do high quality work.

The functional relationships between subject areas, as previously discussed, are equally appropriate within a comprehensive general laboratory. Grouping the subject areas of woods, metals, and construction in one section, for instance; power mechanics and electricity/electronics in another; and planning, including drafting and graphic arts, and other auxiliary facilities in still another not only utilizes the available space more efficiently but also reduces to a minimum the duplication of tools, equipment, and machines. In such an arrangement group activities common to the subject areas—such as layout, cutting, shaping, forming, assembly, finishing or power generation, utilization, and distribution—may be grouped so that pupils may see the relationships and thus teaching becomes more unified. Where two or more comprehensive general laboratories are warranted, the facilities for each should be planned so that the subject area relationships are recognized.

Equipment in the main laboratory is arranged so that there will be a natural flow of material from one operation or process to another. Open spaces and aisles permit such movement from the storage area, where initial processing begins, through the various fabrication stages, to where a product is finished. Machines are carefully grouped according to operations performed, with sufficient space to provide for maximum safety and efficiency and, in the case of woodworking machinery, to localize dust and chips for suction removal. Lathes are best placed near a window wall at such an angle and in enough space to permit the operator to stand and to work without interference from another machine or pupil. Machines which are operated from only the front—such as grinders, scroll saws, and drill presses—or from the side, such as a jointer, are commonly placed back-to-back or with the "dead" side next to a wall or column and with sufficient clearance on the "live" side to permit unhampered operation. Benches for hand operations, assembly, or portable machine use are grouped and located according to functions. Lockerbase type benches, four-station and two-station, with heavy duty tops and vises appropriate for the work to be done are desirable. Small cabinet-type benches on lockable casters are found in power mechanics laboratories for disassembly, assembly, and testing small engines or other power parts or units. They allow flexibility in arranging equipment for functional use. Low, portable, and island-type tool storage facilities which can be used from two sides, the top, or ends are strategically located to minimize travel. These can be relocated as needed.

Related activities—such as those involving hot metals (welding, foundry, heat treatment, and forging)—are concentrated in a corner away from the planning area. Machines for these activities are provided with a common hood and large exhaust fan to remove smoke and fumes. Similarly, small engines, outboards, and other gas-powered products are so located in a laboratory that fumes are removed with a forced exhaust and noise is least disturbing. If large overhead doors are included in the planning, the equipment is arranged to permit sufficient open space in front of the door for whatever functions are to be served—assembling large projects, bringing in large equipment or materials, or servicing automobiles.

The main laboratory arrangement should provide maximum visibility for the instructor in all areas and from any position.

Many teachers have planned their laboratory arrangements using heavy card templates or small models of equipment available from many colleges and universities or from their local State college. This planning was done on a scaled layout so that close approximations could be made for the services to be provided. The planning committee should examine the layout to ascertain that functional facilities have been provided before plans are prepared for locating lighting, power, gas, air, and other services.

According to available research studies, most laboratories use—

* *Four-station, rectangular, 54 by 64 inches, locker-type woodworking benches (2¼-inch hard maple top, 33¼ inches high, 4 vises) are most desirable.*
* *Single-station, rectangular, 28½ by 64 inches, locker-type benches (2¼-inch hard maple top, 33¼ inches high, with machinist vise or woodworking vise) are desirable.*

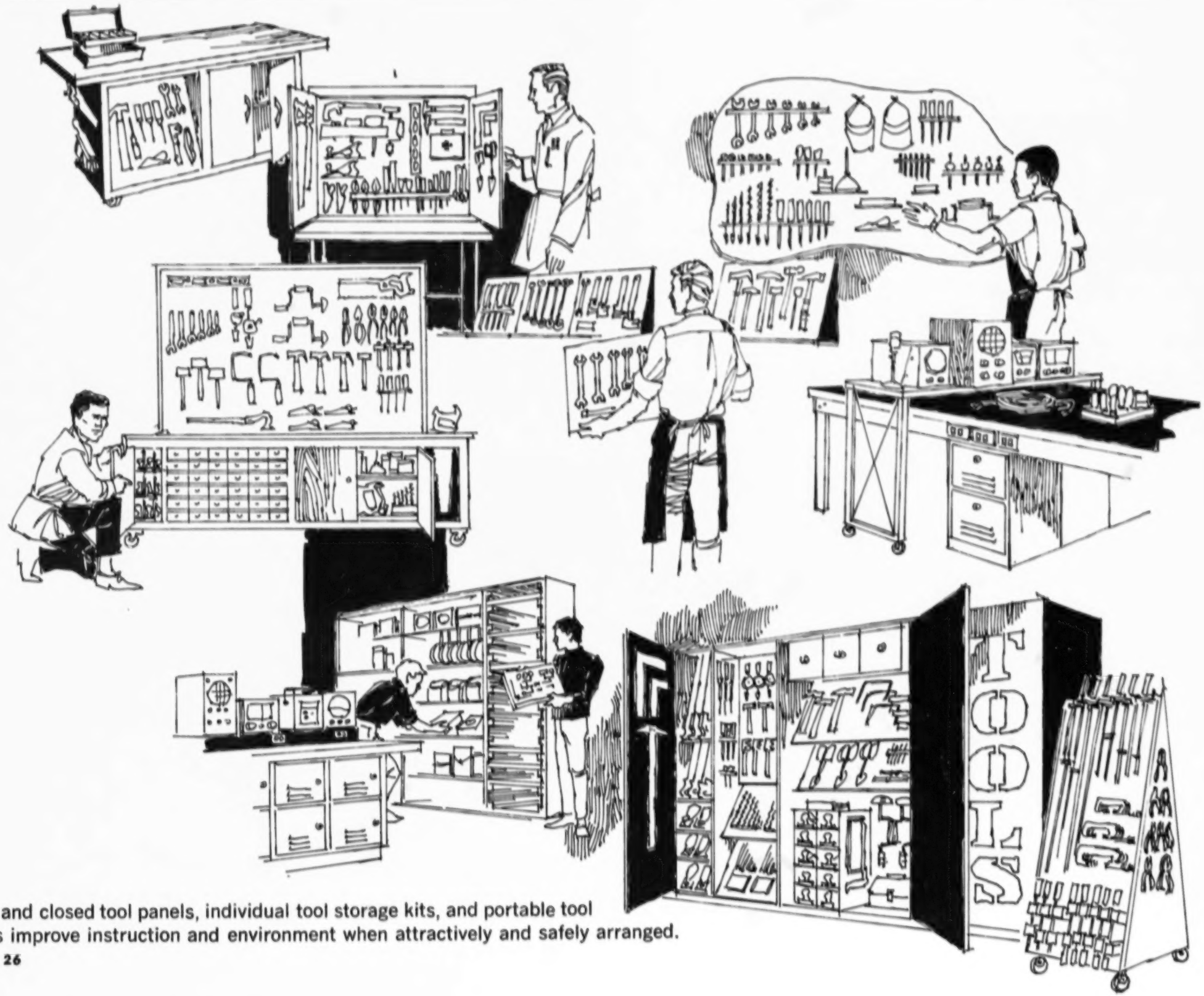
## Departmental Library and Planning Area

Space for a departmental library and planning area is vital to a functional department. Such space can also serve for general assembly and conferences; for sketching, designing, drafting, reading, research, and study; or for using projectuals and other instructional materials. Approximately 600 square feet of space conveniently located adjacent to the laboratories or within the laboratory itself was provided in many of the schools visited by the authors. Where space is enclosed, glass partitions were provided so that the teacher could visually supervise the pupils' activities without being in the area. The following space and facilities should be considered:

* Provisions for chalkboard, tackboard, and overhead or other projectuals.
* Reading and/or drafting tables and chairs.
* Storage space for drafting equipment and supplies.
* Bookcases, magazine racks, card files, and legal-size filing cabinets.
* Space for demonstration facilities.
* Space for instructional materials, teaching aids, and displays.
* Sufficient space for movement of instructor or pupils without impeding one another or bumping into equipment.
* Provisions for sound and light control, ventilation, or air conditioning.
* Provisions for electrical outlets for projectors, recorders, television, and other electronic aids.
* Provisions for an uninterrupted view of pupils in all areas of laboratory.

Research studies show that the departmental library and planning area should be combined in a space centrally located and convenient to the industrial arts laboratory or in an adjacent room, and that chalkboards (4 by 6 or 4 by 8 feet) should be installed in the teaching center.

Handy references, tools, and materials for drafting or planning should be arranged conveniently.




Open and closed tool panels, individual tool storage kits, and portable tool racks improve instruction and environment when attractively and safely arranged.

## Storage Space

Lack of adequate storage space and facilities in industrial arts laboratories was a problem mentioned most frequently by the teachers during the school visits. Functional storage compartments not only protect and conserve materials and tools, but also help pupils acquire systematic habits of putting items where they belong after using them. Adequate storage is needed for tools and instruments, materials and supplies, projects, pupils' personal belongings, and instructional media and supplies.

*Tools and Instruments.*—Several methods for storing tools are found, such as open wall tool panel, closed wall tool case, individual tool kit, bench, tool room, and portable carts. In addition to personal preference, factors which determine the storage method used are convenience and accessibility, ease of checking, security of tools, special and precision requirements, and costs. The following space requirements and considerations are suggested when planning for tool storage:

* Sufficient wall space should be provided on all sides of the laboratory uninterrupted by windows, electrical outlets, plumbing, or other facilities. Space may be used beneath high windows, but not beneath low windows.
* Centrally located space should be available for storage of tools which are used in processes performed in any part of the laboratory.
* Localized space should be provided for storage of tools designed for a specific phase of a subject area or for a machine. Where feasible, tools and accessories for a specific machine may be stored on a panel attached to the machine.
* Space immediately in front of general tool storage areas should be sufficiently large and free from benches, machines, or other equipment that may interfere with ready access to the tools.
* Space should be provided for storage of hand power tools, either on racks near work centers where they are used frequently or in centrally located general tool storage areas.
* Storage space that is dust and moisture-free as well as lockable should be available for micrometers, verniers, and other precision instruments.
* Space is needed for movable, special tools and/or instrument carts where used. Dust, moisture, and temperature controls for the latter may be required.

*Materials and Supplies.*—Storage space for materials and supplies varies with the subject areas. Several types of facilities were used in the schools visited, including separate rooms, cabinets, racks, bins, shelving, drawers, and lockers. A general storage room or area for the materials and supplies of all the subject areas in the department was found most effective for both ease of administration and control. Economies resulting from long-range and quantity purchases also make such a room for storage desirable. Materials and supplies which are used daily are stored in the laboratory near the area where they are used. Both horizontal and vertical storage of lumber and metal was observed. Horizontal racks occupy more floor space but keep lumber flat, particularly plywood or other sheet materials. On the other hand, vertical racks require less floor space but a greater ceiling height. Metals and plastics, both sheet and bar, are usually stored vertically for ease of handling. Below are suggestions for space and facilities:

* Space for general storage of materials and supplies, particularly lumber and metal, near the delivery entrance to reduce the distance bulky materials must be moved and to keep traffic congestion at a minimum.

* Space not less than 18 feet long, if horizontal storage of lumber is used.
* Space for adjustable shelving for coiled and packaged materials and supplies.
* Space for cabinets with adjustable shelving and/or drawers and doors for small and more costly supplies, and for extra tools and small equipment.
* Space for metal cabinet or adjustable shelving for flammable materials and oils.
* Space for paper stock and other sheet materials.
* Drawer space for electronic supplies, screws, nails, and hardware.
* Localized storage space for materials and supplies peculiar to a specific subject area, such as electronic experiment panels.
* Master-keyed locks for storage cabinets and lockers.
* Space to permit easy access to any or all storage facilities.

*Projects.*—The storage of projects which are either in the various stages of construction or in the process of finishing creates a major space problem in the laboratory. The number of pupils, day and/or evening, and the type of projects to be made indicate the amount and kind of space needed. Some schools provide special compartments of substantial capacity for storage of unfinished projects, adjustable shelving to accommodate projects of different sizes, and separate storage for evening and regular class projects. Suggested space and facilities for storing projects include:

* Facilities for storing projects near the bench or area where work is being done on them, as locker type benches.
* Space for storage of projects underway by individuals, divisions, or classes.
* Space for projects of different sizes and shapes, standing upright or lying down.
* Dustfree and properly ventilated space for projects being finished and in drying stages.
* Space for storage of flat or sheet projects, such as drawings and printed or silk-screened matter.
* Master-keyed door handles or locks for storage lockers.

Research studies reviewed recommend that a separate storage room be provided for projects—unassembled, assembled, and finished—and that individual classes have storage space.

*Pupils' Personal Belongings.*—Lockers in the laboratory are used for storing pupils' personal belongings, unfinished projects, as well as instructional supplies. In some of the schools visited, each class group had separate lockers or a special enclosed space which remained locked except when in use. In other schools where pupils changed into special clothing or put on coveralls over regular clothes, particularly in power mechanics and general metals laboratories or classes, lockers or wardrobes were provided. Some suggestions for space and facilities are:

* Space for standing lockers in a separate room or area located for easy supervision by the instructor at the beginning and close of a regular class.
* Provisions for multisize lockers under benches, with spring hinges and master-keyed locks.
* Provisions for books in lockers or on shelving over or adjacent to lockers.
* Space for lockers for adult or evening class storage of personal belongings.

Proper storage of materials makes the industrial arts laboratory neat and efficient.

*Instructional Media and Supplies.*—Flexible space arrangements for keeping instructional media and supplies in either the departmental library and planning center or a separate audiovisual room were found in the laboratories visited. Storage facilities for teaching aids and machines varied widely, including compartments in or near the teacher's desk or office; cases specially designed to hold charts, pamphlets, and the like; movable carts for holding machines stored in the audiovisual room, planning center, or teacher's office; and four-drawer files. Models, mockups, or displays were stored in or on top of cabinets, on shelves, or on counters in areas of the laboratory where they were used by pupils. A rear-view projection cabinet provides an excellent storage space for motion-picture and slide projectors, a tape recorder, as well as films, slides, tapes, and spare lamps.

The following spaces or facilities for storage of instructional media and supplies are suggested:

* Space for flat and rolled charts, easily accessible.
* Space for models, mockups, specimens, and three-dimensional aids.
* Movable cart (low) for overhead projector.
* Movable cart or rear-view projection cabinet to house motion-picture and slide projectors, tape recorders or record player, films, slides, slide films, lamps, splicing equipment, and supplies.
* Space in planning center or separate audiovisual room for storage of movable carts and equipment.
* Space for storing card stock, paints and brushes, lettering pens and ink, and other supplies for use in making aids.
* Space and facilities for making overhead transparencies and storing supplies and equipment.

Research studies recommended that a special room for using audiovisual facilities be provided for industrial arts laboratories, or provisions made for darkening the laboratory.

The effective use of new instructional media depends on adequate storage spaces.

### Finishing Room

Finishing rooms are generally found in woods laboratories and to a lesser degree in other labs. Many rooms observed by the authors were dustproof and equipped with an independent exhaust system (exhaust fans were 24″ and over). Some were conveniently divided into two areas, one for spraying and the other for hand finishing. Steel cabinets were used to store paint supplies; liquid solvent metal containers had closed, spring-loaded tops. The door to the finishing room in many of the schools was vapor-sealed. Light switches were also sealed or located outside the room. Ceiling lights were flameproof. In some schools visited, a drying room occupying 200 to 225 square feet was adjacent to the finishing room. It had a wide door for large objects, the area was dustproof, and special attention was given to the ventilation system.

Below are suggestions on space and facilities:

* Space for finishing either in a separate room or in a relatively dustfree area of the laboratory.
* Exhaust and ventilation provisions to remove noxious and toxic odors.
* Fireproof and/or vapor-proof electrical services and facilities.
* Provisions for fresh air and adherence to air regulations.
* Fireproof storage for volatile solvents and finishes.
* Self-closing metal container for soiled rags.
* Space for metal storage cabinet for brushes and supplies.
* Space for bench or rotating finishing stand.
* Washup sink with hot and cold water and suitable drain.
* Master-keyed locks on all storage cabinets.
* Space for cabinets or shelving and equipment peculiar to a finishing room that is used with other subject areas, such as metals, or as a project storage area.

## Darkroom

The developing or printing of photographs or the making of negatives for offset printing requires a darkroom. In some schools visited, a small room from 80 to 90 square feet was provided for photographic processing and was used at times by other departments in the school. In the modern graphic arts laboratory, the darkroom is a requisite for photo-offset printing. Space and facilities suggested for the darkroom are:

* Rectangular space located adjacent to the graphic arts platemaking or offset press area.
* Space for an offset camera (horizontal or vertical), a developing sink, an enlarger, a print dryer, cabinets, working-height counters, and a contact printer.
* An acid-resistant sink with hot and cold running water and trays for developing and washing negatives and prints.
* Provisions for hanging roll or sheet negatives for drying.
* Shelf space for chemicals and accessories.
* Enclosed space for unexposed negative and printing papers, with sliding doors and master-keyed lock.
* Ventilation and temperature controls.
* Provisions for safe lights, spotting light near camera, and normal lighting (safe and spotting lights to be controlled locally, and normal lighting switch to be located near the entrance).
* Provisions for a maze or other light-tight control at the door.
* Provisions for an occupancy warning light outside the darkroom and a means of locking the door from either side.

## Display Area

Display facilities in the industrial arts serve as a public relations medium and as instructional aids. They may consist of open shelving, particularly where three-dimensional items may be displayed for instructional purposes, or as tackboards to display students' flat work, charts, pictures, or other information. They are usually found in the planning area and in the laboratory itself. Recessed, glass-enclosed cases are most often located along corridor walls either adjacent to the laboratory or in a general display area near the school entrance. Suggestions for space and facilities include:

* Sufficient wall space for tackboards in the planning area and in the laboratory, especially near the entrance. Tackboards on each side of chalkboard may be used.
* Space for open shelving for three-dimensional items—projects, models, or process displays.
* Recessed, glass-enclosed space in or outside the laboratory with provisions for lighting, open or free standing shelving, tack or pegboard on one wall, and large opening with sliding or swinging doors which can be locked.
* Provisions for hanging displays on the wall of the laboratory.

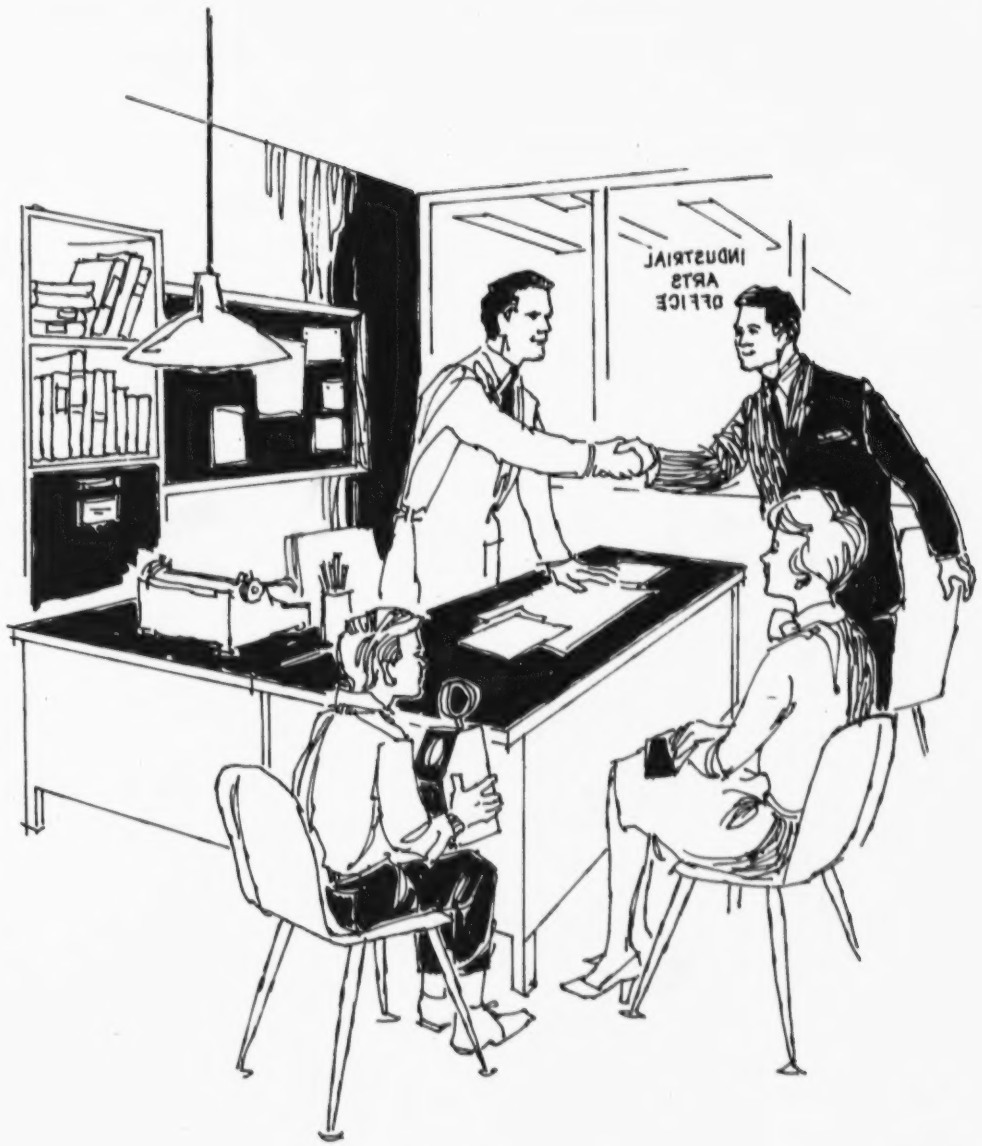
Research studies recommend that:

* Picture molding or channel should be built into the windowless walls for hanging pictures and displays.
* A bulletin board, approximately 16 square feet, should be provided near the most frequently used entrance of the laboratory.

## Teacher's Office

Many secondary schools provide separate space for teachers to keep books, records, instructional materials, and other items of a private nature, as well as to hold conferences with pupils or parents. An area of from 125 to 150 square feet for each teacher is found in some schools. In smaller departments, space in the planning center is provided for this purpose. Suggested space and facilities for the teacher's office are:

* Space for a desk with one drawer file, chair, and typewriter.
* Space for one or two chairs for conferences with pupils or parents.
* Space for reference books and bulletins for the teacher's exclusive use.
* Space for storing films, filmstrips, or other audiovisual aids.
* Space for storing pupils' projects when they are being evaluated.
* A four-drawer standard file for budgets, inventories, accounts, letters, pupil records, and other materials pertinent to the department.
* Provisions for ventilation, thermal or air conditioning, and sound control.
* Provisions for electrical outlets, adequate lighting, and color conditioning.
* Provisions for telephone or other communications media.
* Space adjacent to or in planning area to provide an overall view of the laboratory.




Guidance is an important part of the industrial arts program.

## Toilets and Washing Facilities

Toilet facilities were provided in many of the departments visited, particularly if the departments were located in a separate building or were too far from the school building's toilets. Facilities for both males and females were generally included.

Each department and generally each laboratory had its own washing facilities. These were placed against a wall with several mixing valves which deliver water of controlled temperatures. This type is often used because it is economical in the amount of water used as well as in the amount of time it takes to wash under a concentrated stream. Semicircular and circular washup fountains with foot controls were also used to permit several pupils to wash at the same time. The floor and the wall behind the wash trough generally had an impervious finish. Towel and soap dispensers were provided, and mirrors were included in some laboratories. Most of the facilities visited had a drinking fountain in the laboratory and near the sink area. Space and facilities must adhere to local sanitation and building codes.

Research studies show that teachers prefer wall-type washing troughs, with one mixing valve for every 10 to 12 pupils.

## Aisles of Travel

Another concern of the planner is provision for flow of traffic—to permit pupils to move from one work station to another, or to materials or tool storage center without interfering with other pupils or bumping into machines or benches along the way. Aisles should be provided to permit such movement. Space considerations observed or suggested include:

* Sufficient space between benches, machinery, and equipment to permit pupils or teacher to pass without interfering with a worker at a station.
* Space for movement of bulky materials to cutting machine or area without crossing or blocking major aisles.
* Open space in front of tool panels or storage areas, lockers, washup areas, planning center, display areas, entrances, and exits.
* Minimum space of 4 feet for major aisles and 3 feet for minor or feeder aisles.
* Open floor spaces in laboratories where assembly of projects or construction of model structures are required, and for flexible arrangement of equipment to meet special or new needs.

# CHAPTER V ■ Planning the General Physical Environment

PLANNING THE GENERAL PHYSICAL SETTING of the industrial arts department to assure maximum functionalism and flexibility should be undertaken only after the space and facilities discussed in the preceding chapter have been carefully considered. The planning committee, and the industrial arts teacher in particular, should impress upon the architect the needs outlined and provide him and the engineer with specific details of physical features essential to learning and teaching and to organizing and managing the facilities.

## Location of the Department

The location of the industrial arts department in schools varies considerably. In large cities where ground space is at a premium, it is located on different floors. Elevators are used to transport supplies and equipment. Suburban schools generally have the department on the ground level convenient to an outside entrance and service drive. In some schools it is in a separate building nearby and connected by a canopy or covered passage to protect pupils during inclement weather. A wing of the school is used for the industrial arts department in many communities. This location not only provides for accessibility from a service drive but also has the additional advantages of providing for expansibility; permitting entrance from the outside for pupils or adults in after-school hours, vacations, or in the evening without opening or disturbing the remainder of the school; controlling sound, dust, chips, and fumes; and permitting higher ceilings where needed. The activities and the interrelationships which exist between industrial arts and science, home economics, art, and the vocational-technical courses make close proximity to these facilities most desirable.

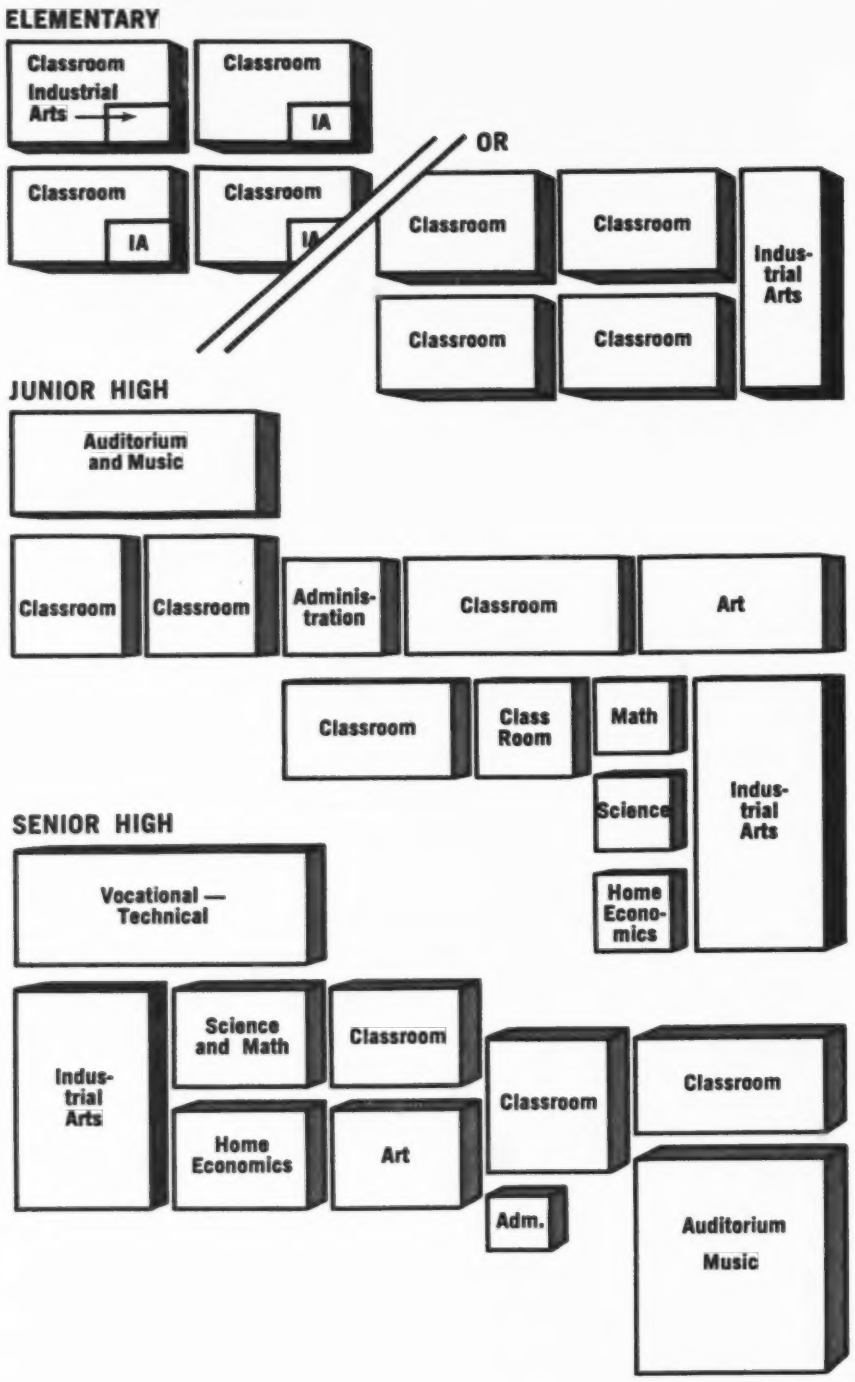
Research studies reviewed recommend that industrial arts laboratories be located on the ground level, in a wing of the main building, or in a separate building near a service drive.

## Spatial Factors

The location of the industrial arts department can be influenced by the size, shape, and height of the facilities. Some of the elements that determine these spatial factors include: number and age level of the pupils, subject areas, equipment, auxiliary facilities, open spaces, and aisles needed for both flexibility and safety.

*Size.*—Once the planning committee ascertains the data pertinent to these elements, it may then calculate the floor space needed. The total amount of space provided for the facilities should not only meet the needs of the current program but also be adaptable to changes for future programs. The research studies examined report the space range, based upon 20 to 24 pupils per class and excluding auxiliary facilities, as follows:

* From 1,800 to 3,000 square feet for general unit laboratories, such as woods, metals, graphic arts, drawing, or comprehensive general laboratories.
* From 1,800 to 3,000 square feet for power mechanics or transportation laboratories.
* From 1,200 to 2,400 square feet for electricity/electronics and crafts laboratories.




Locating the industrial arts department near other related curriculum areas makes correlated activities easier.

The total area of laboratories is often determined on the basis of a square foot (range from 75 to 150) per pupil ratio and an assumed class size (for example, from 20 to 24 pupils). Such a ratio, however, is not valid for very small classes since the equipment needed in a laboratory, in order to provide for the necessary learning experiences, takes up about the same amount of space.

*Shape and Height.*—Generally the shape of laboratories is rectangular. Suggestions received from teachers during the school visits indicated that the width should be no less than 30 feet and that power mechanics laboratories should be wider to accommodate automobiles, boats, and other large equipment. However, some newer ideas regarding the space of the laboratory are shown on the inside front cover.

Ceiling heights in laboratories ranged from 12 to 22 feet, but the latter footage was generally considered too high. Where a car lift is used in the power mechanics facility, the ceiling should be higher to accommodate the car lift.

Research studies on laboratories showed that:

* The shape should be from 1:1½ to 1:2 (example: 40 feet wide by 70 feet long).
* The range of height should be from 12 to 14 feet.

## Architectural Considerations

The architectural details which follow are pertinent to functional facilities for industrial arts and require the attention of designers and planners. Many of these were observed by the authors and were reported in the research reviewed.

*Flooring.*—The type of flooring selected for the laboratories varies with the needs of the activities to be accommodated. Considerations must be given to floor surfaces which are: (1) designed to endure, but not so nonresilient as to cause undue fatigue; (2) insulated to prevent noise; (3) pleasing in appearance; (4) cleaned easily; (5) finished to reduce the

danger of slipping; and (6) repaired easily and effectively. Generally, in laboratories where floors are subjected to oils or severe usage, or serve different subject areas—such as metals, power mechanics, and ceramics—a hardened, sealed concrete floor is recommended. In other laboratories, a resilient type flooring—either maple, vinyl asbestos, or solid vinyl—may be used. A ceramic tile floor is preferred in the ceramics laboratory or area. Floor areas where machine operators stand need special treatment for safety reasons, such as a nonskid surface.

*Walls and Doors.*—Of special concern to the planners of functional facilities are the types of walls and the location and sizes of doors. The wall materials of a laboratory are usually the same as those used throughout a school plant. Planners should, however, consider using a wainscot of 4 to 5 feet, with a hard, easy-to-clean surface. An enclosed planning area or office is particularly appropriate for a wainscot, to provide space for equipment on both sides of the wainscot, with a glass area above to permit visibility of the whole laboratory. If concrete blocks are used, they should be properly sealed and coated with an epoxy or plastic finish paint. Movable walls or partitions of metal, wood, or concrete block should be non-load-bearing and contain no utilities.

The size and swing of doors can either make the adjacent wall space useless or reduce the functions of a laboratory by limiting access to it or its auxiliary facilities. If cars are to be driven into a power mechanics or transportation laboratory, a ramp and wide overhead door is helpful. The location of the door is determined by the size and shape of the laboratory, the service drive, and the number of cars to be admitted at one time, but it should be at least 7 feet from a corner to permit work and free passage. A hydraulic car lift will also influence the location and height of the door. An overhead or larger, exterior swinging door may be used in a woods laboratory when lumber or bulky objects are delivered or removed. The space in front of this door may be utilized for large construction as well. An entrance to the laboratory from the outside is important for evening class use. This may be placed next to an overhead door or, as in some instances, within the door itself.

Interior doors should not be less than 3 feet wide and preferably wider. Where doors wider than 4 feet are needed, as for a finishing room or between laboratories for moving equipment, double, swinging doors or, under some circumstances, bifold or sliding doors may be considered. Doors should swing away from usable wall space yet not interfere with free passage in the room. Placing doors close to a corner where possible will permit better room and wall utilization. Fire safety laws should be consulted concerning door requirements.

*Plumbing.*—Hot and cold water is needed in or near a finishing room, in the photographic darkroom, and in the ceramics area. Cold water is also required for quench tanks in the metals and the power mechanics laboratories. A tap is needed near an overhead door or outside entrance for use in or outside the building. Facilities for outboard motor operation and testing must have water.

Acid resistant plumbing fixtures must be considered for photographic processing and for metal finishing which involves etching and electroplating. A special sink trap and a floor drain are especially desirable in the ceramics area. Volatile liquid interceptor floor drains in the power mechanics laboratory are mandatory if cars are brought in or if fluid power activities are conducted or planned. A floor-level capped pipe leading to a buried storage tank outside the laboratory is desirable for disposing of waste oils.

Plumbing for compressed air and gas lines is essential. Compressed air is needed for almost every industrial arts facility for operating cleaning, spraying, cooling, and other pneumatic tools or equipment. Natural, mixed, artifical, or bottled gas

is used to heat soldering coppers, foundry and heat treating furnaces, and sometimes kilns. Supply lines for air or gas may be either underground or along a wall overhead. Air lines originate at a compressor which should be located not too far from the power mechanics laboratory or a finishing room, and they should be extendable to those areas where needed. Air may be tapped off at any point, using quick disconnects attached to the line and hoses. In a finishing room or other laboratory where variable air pressures are required, air transformers are also connected in the line. Gas lines are directed from their source to the areas where gas is used, and are provided with shut-off valves before being attached to the equipment. Air lines should make provisions for drops in pressure as their length increases, and should also be pitched to permit water condensate to be tapped off either at the compressor or in the line. Air, gas, and in some instances water lines may be piped into a planning or demonstration center, especially in the power mechanics laboratory.

*Electrical Service.*—Designers of the electrical service systems for industrial arts departments must make certain that circuits and outlets are adequate in number, kind, and capacity to meet present and future needs of the various laboratories for both machines and lighting. Centralized boxes or panels utilizing individual circuit breakers and lock-latch doors are highly desirable in each laboratory. A keyed reset switch for panic buttons which are strategically located in the laboratory should also be provided at the master control panel. Sufficient outlets along the walls where power equipment may be located or used are necessary for flexibility; however, tool or cabinet storage and displays should be considered in placing the outlets. Self-retracting drop outlets over benches for portable equipment are desirable. An overhead bus-way system can be designed for equipment located away from a wall, or an underfloor trough may be used for electrical power and the dust collection system in the woods laboratory or area. Floor type outlets, if included, must be covered and flush with the floor.

Services should be planned for instructional media—overhead and other projectors, recorders, and closed-circuit television; for clocks, signalling, telephone, and other communications devices; and in the electricity/electronics laboratory, for central and/or individual power supplies.

Special attention, such as a red "bulls-eye" jewel indicator to control switch, should be given to electrical services for welders, kilns, electric furnaces, and other equipment with high amperage ratings.

Research studies examined suggest that:

* 220-440 volt three-phase and 110-120 volt single-phase grounded electrical system should be installed to meet electrical power needs.
* 110-120 volt grounded double wall outlets, located 36 to 42 inches above the floor and spaced 10 to 15 feet apart, should be installed along the walls.

## Conditioning Space

Planners and designers of properly sized and arranged physical facilities for industrial arts must make sure that each laboratory has good quality-level visual, temperature, and sound controls and proper interior finishes for safety, attractiveness, and educational usefulness.

*Visual Control.*—A lighting system should be chosen to meet the requirements of the job to be done. Two considerations should be uppermost in the minds of the planners: (1) Will it allow pupils and teachers to see without distraction? and (2) Does the appearance of the installation fit the architectural design? To meet these conditions, industrial arts laboratories use both natural and artificial lighting.

### Natural Lighting

Windows, sky domes, and clerestories are the sources of natural lighting. Windows with high sills from 5 to 7 feet from the floor are recommended by many teachers to prevent glare on work areas and to provide space under the windows for storage, machines, and other equipment. North and east light should be planned for whenever possible. The trend in current school construction toward less window space in outside walls of academic classrooms and laboratories should please planners of industrial arts facilities in view of their need for wall space.

Dome and clerestory lighting are less commonly found than outside wall windows. Where they are used, it is recommended that low-transmission glass or plastic be installed to prevent glare and excessive heat from the sun. Sky domes should have sealed inner and outer domes, one clear and the other white or frosted, to provide better light diffusion and to eliminate condensation problems.

Natural lighting may also be introduced into the laboratory by providing an above-ceiling cavity that allows sunlight to diffuse into the room through a translucent or lowered ceiling.

### Artificial Lighting

Artificial lighting systems should provide a uniform distribution of shadow-free, glare-free illumination that conforms to adopted standards.[1] Artificial lighting for the industrial arts department should equal that recommended for academic classrooms; however, for drafting, where precision work is carried on, lighting intensity should be increased. General artificial lighting should be by indirect or semi-indirect fixtures, incandescent or fluorescent, the latter provided with ballasts having a low noise level. General lighting should be supplemented with additional local lighting on machines and in areas where precision work is done. Lighting and fixtures for the finishing room, darkroom, and display areas should meet the special needs of these areas. Colors, discussed in a later section, have great influence on lighting.

Research studies show that:

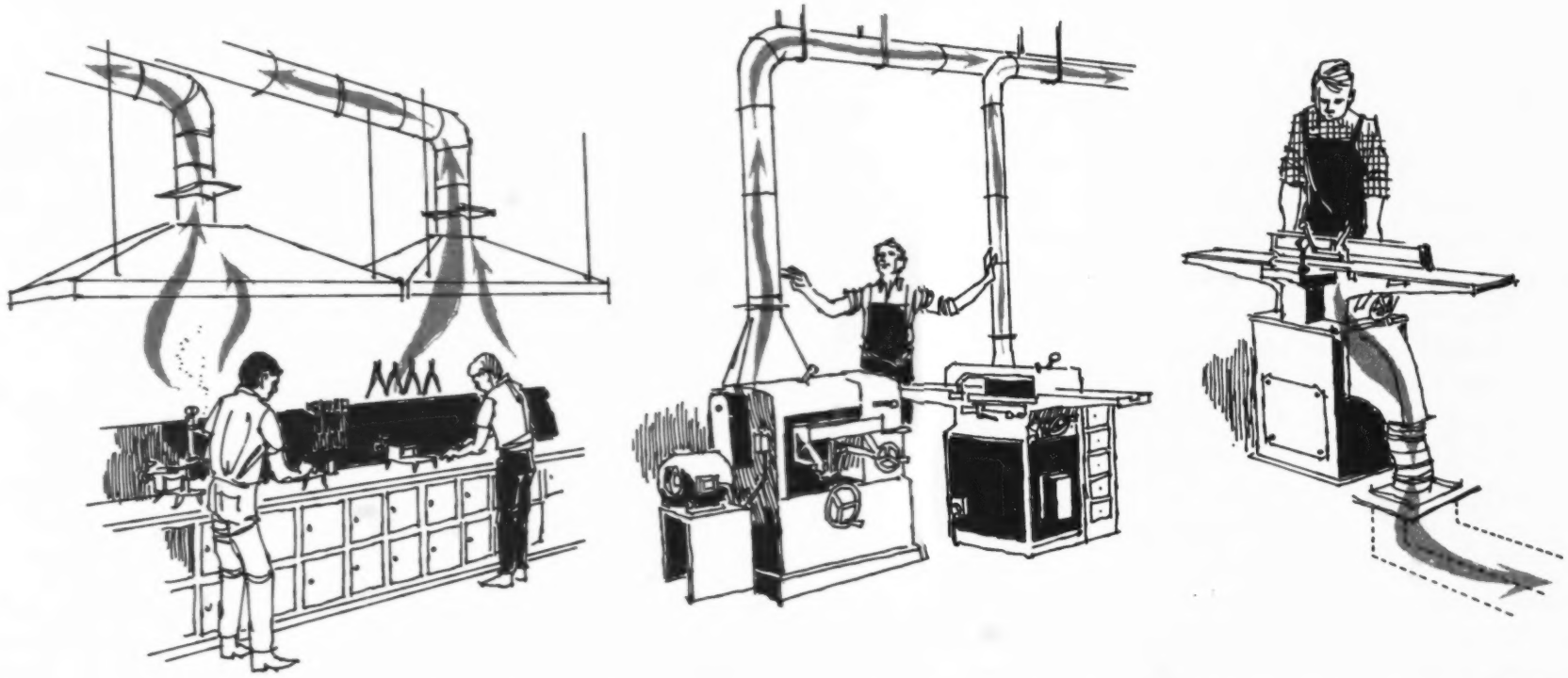
* Fifty to sixty foot-candles of light are necessary at bench height.
* Fluorescent lighting is recommended for industrial arts laboratories.

*Temperature Controls, Ventilation, and Exhausts.*—Maintaining the proper thermal environment is an important factor in the most productive use of time and space. The condition of the air and the surface temperature in the department affect the physical and mental comfort of pupils and their efficiency in learning.

The temperature level required in industrial arts laboratories should be determined by the activities carried on. Where the activities are vigorous, the temperature may range from 60 to 70 degrees F.; but in areas where activities are moderate, it may be from 68 to 72 degrees F., measured 5 feet above the floor. Laboratories with furnaces, welders, and other heat-producing equipment may require less heat. In the power mechanics or transportation laboratory where large overhead doors may remain open a period of time, especially during winter months in colder climates, a quick heat response is needed. Controls which can be conveniently regulated should be provided.

Relative humidity in a laboratory must be carefully controlled at about 45 percent to prevent the surface oxidation of tools and machines, the opening of jointed wood tops, or the curling of paper in a graphic arts laboratory.

[1] *American Standard Guide for School Lighting.* A manual prepared jointly by the American Institute of Architects, the Illuminating Engineering Society, and the National Council on Schoolhouse Construction. New York: Illuminating Engineering Society, 1962.



**Proper environmental control may be achieved through the use of hoods, overhead and under-the-floor pipes, and ducts.**

Large window areas in outside walls can cause solar heat to vary widely, high when the sun is shining and low when the sun is not shining. The use of large areas of glass is being questioned as more schools, because of their location and the increased use of their facilities during the summer months, consider air conditioning. Laboratories with west and south orientations, particularly in southern States, should have outside wall windows of low-transmission glass to improve the performance of air conditioning systems.

A carefully controlled atmosphere in classrooms prevents stress, strain, and fatigue on pupils and teachers alike and improves both the instruction and learning. Air conditioning can be of major benefit during day, evening, and summer programs. In addition, those teachers who already have air-conditioned facilities indicate that the air is cleaner and less humid, resulting in reduced equipment maintenance and replacement costs.

A ventilation system should provide fresh air constantly, especiallly in small or closed spaces, such as the planning areas, teacher's office, darkroom, and finishing room.

Special exhaust ventilating facilities are needed in the industriall arts laboratory. For example, fume and smoke hoods should be provided in the metals laboratory in the hot metals and soldering areas, finishing room, and darkroom. Underfloor forced air exhausts to remove fumes from gas-powered equipment are essential. A dust and chip collection system, either underfloor or overhead, is desirable for woodworking machinery for the health of both teacher and pupils. A flexible hose connection from the equipment to the system not only reduces the noise level but also permits greater flexibility in locating the machinery. Capacity, flexibility, noise level, and ease of maintenance should be considered in the selection of exhaust and collection system. Localized switches and controls for these facilities should be provided.

*Sound Control.*—Many noise-producing activities are carried on in the industrial arts department. These may become distracting to pupils and teachers both in the department itself and in other departments nearby. Therefore, adequate noise treatment and interception must be provided. Because doors are sometimes left open, the laboratory is often planned so that openings are away from academic classrooms, libraries, and other quiet activity areas.

The type of construction materials needed for adequate sound interception is generally suggested by acoustical engineers and architects, who also determine where absorption materials are to be placed in the laboratory. Limiting noise-treatment materials such as acoustical tile to the ceiling is a common fault. Special attention to sound control should be given to (1) an enclosed planning area, if used, between the instructor's office and the main laboratory; (2) the bases and feet of rotating, vibrating, and impact machinery and equipment; and (3) a listening area in the electronics laboratory, especially in the amateur radio room.

*Finishes and Colors.*—Too often, because of its activities, an architect or planning committee may ignore aesthetic features of the industrial arts department. For example, beams, columns, and other structural elements not only supply the skeleton of an industrial arts department but may also have a beauty of their own if the architect considers unity and proportion in the design.

Attention should be given to surface finishes on walls, woodwork, furniture, and equipment. Furniture of a neutral color with a nonglare finish is often used. Glossy surfaces should be eliminated in order to avoid disturbing highlights. Semiglossy surfaces should be discouraged; however, they are sometimes seen below eye level for areas where frequent cleaning is necessary.

Paint finishes are generally flat or matte on all interior surfaces at eye level. The walls observed in many laboratories were green, the ceilings white, and the floors gray or a natural finish. These colors seemed to be aesthetically and psychologically suitable. Trim is often finished with a 40 to 60 percent reflection factor paint; desks and equipment, 30 to 50 percent; floors, 30 to 40 percent; and chalkboards, 20 to 25 percent.

Color can destroy or reaffirm the beauty of a building—its unity, its proportion, and the seeming flow of space. However, its psychological effect on pupils must be considered. For example, greens, aquamarines, and blues appear to be restful, while reds are stimulating, yellow exhilarating, and some browns and grays depressing. Color can be used to identify danger zones. Northern rooms can be benefited by warm colors; warm exposures, by cool colors. The frames of machines should be of neutral shades (gray or green was observed quite often during school visits). Light will provide maximum visibility at critical points—on a metal lathe, for example—for ease in reading measuring instruments. School industrial arts laboratories and drawing rooms painted "eye-rest green" were attractive and practical. Other colors in common use for safety purposes are: fire protection—red; safety—green; visibility—yellow; traffic—white, gray, or black; alert—orange; and precaution—blue.

*Safety and Health Concerns.*—A school board must provide and maintain school facilities which safeguard the life and health of pupils, teachers, and other persons who enter the school plant. The school board and school personnel are also responsible for preserving and protecting school property.

The following is a checklist of precautions on safety and health which planners of industrial arts laboratories should keep in mind as they develop specifications:

1. Are sufficient fire extinguishers, of the proper type and conspicuously marked, located near danger areas in each laboratory?
2. Is a first-aid kit provided for emergency use *only*?
3. Are all sections of the laboratory clearly visible to the instructor from any point?

4. Are machines located so that neither the operator nor other pupils are in direct line of danger?
5. Is spacing between benches, machinery, and other equipment sufficient for pupils' safety and free passage?
6. Are supplies so arranged that pupils can obtain them safely and efficiently?
7. Are open floor spaces provided near entrances and exits to eliminate congestion?
8. Are nonskid surfaces provided at the operator's position near machines?
9. Are all floors finished so as to reduce the danger of slipping?
10. Are operators' safety zones at machines designated on the floor by painted lines or in some other way?
11. Is a vehicle hoist instead of a pit used in a power mechanics laboratory?
12. Are exhaust fans for fumes, smoke, and other toxic odors sufficiently large to eliminate hazards?
13. Is a collection system provided for machines to free the air of dust or other contaminants?
14. Are machines properly grounded and fused individually?
15. Are panic buttons strategically located in laboratories where hazardous machines are used?
16. Are electrical facilities in a finishing room approved for the purpose intended?
17. Are fluorescent tubes and incandescent lamps properly shielded?
18. Are surface finishes on walls and ceilings glare-free but durable?
19. Are chalkboards a durable, restful color with a low light reflector factor?
20. Is the laboratory arrangement designed for good housekeeping as well as for flexibility and function?
21. Are windows placed high enough to eliminate or reduce glare to a minimum?
22. Are adequate washing and toilet facilities provided?
23. Are all gas, water, and air lines equipped with shutoff valves in the laboratory?
24. Are laboratories acoustically treated for control of noise, and are provisions made for reducing noise transmission through floors, walls, and/or columns?
25. Are clearly defined aisles provided for safe egress from the laboratory or from one section to another?
26. Is the floor in the hot metals area fireproof?
27. Are concrete floors sealed and hardened to keep dust at a minimum when they are being cleaned?
28. Have floor drains been provided to remove water or other liquids in the power mechanics laboratory?

# CHAPTER VI ■ Summary and Recommendations

THIS PUBLICATION HAS PRESENTED AN APPROACH to functional planning of industrial arts facilities. This chapter summarizes the main ideas under two headings—*General Guidelines* which are relevant to all phases of industrial arts and *Specific Guidelines* which curriculum planners can use as an evaluative instrument to make individual judgments on specific facilities. In the final section, *Recommendations for Improving Industrial Arts Education*, the specialist for industrial arts has attempted to extract meanings from the data presented and to suggest ways to strengthen industrial arts instruction in the United States.

## General Guidelines

The following general guidelines may suggest some basic planning ideas for creating functional industrial arts facilities:

- Space and facilities should be designed so as to encourage effective instruction at both the elementary and the secondary school levels. Well-planned facilities that assist teachers to perform their tasks safely and with a minimum of lost time and effort are requisite to a program which attempts to characterize modern industry.
- Space and equipment must be flexible to accommodate a variety of activities and learning experiences for large and small groups of students in day and evening classes, and teaching techniques unique to industrial arts.
- Effective use of electronic and mechanical teaching aids—such as projectors, recorders, mockups, and other devices—will depend largely upon their accessibility and storage.
- Facilities selected must provide for the physical differences, such as pupils' strength, coordination and control, and height.
- An atmosphere and setting conducive to the health and safety of pupils—involving ventilation, thermal and air conditioning, lighting, and color conditioning—should receive careful consideration.
- Space for planning, research, demonstration, and the use of instructional media and resources is imperative.
- Adequate but flexible electrical service should be provided to permit rearrangement of equipment as dictated by the needs of the program.
- Space and facilities should be designed to fulfill current curriculum needs but flexible enough to adapt to changing requirements and future needs.
- The proposed physical setting and its design should be such that an architect can readily incorporate it in the overall building plans.
- Efficient and convenient space for the storage of tools, equipment, supplies, materials, as well as pupils' projects in various stages of completion is mandatory.
- Space for the free flow of traffic with easy movement within the room, to and from storage compartments and work stations, and for access to the school grounds must be considered.

## Specific Guidelines

In addition to the preceding general guidelines for planning industrial arts facilities, the following specific guidelines gleaned from the research and discussions with teachers, planners, and architects may be used as a checklist for evaluating a specific plan. Each guideline is in the form of a question, followed in some cases by a statement to help the evaluator determine whether or not this specific guideline is achieved. A rating scale from 1 to 5 can be developed and used for each question. For example, a 1 rating can mean low in achievement; a 5, high.

*Do the educational specifications clearly identify the objectives to be achieved and the instructional content to be taught?* Examine carefully the stated objectives and the relationship of the topics, concepts, or units of study to be taught in the industrial arts program. The printed State or local curriculum guide is of invaluable assistance in this task.

*Is the instructional resource area centrally located?* Various supplemental instructional materials should be within easy access of students. The instructional resource or planning area, or departmental library should become a focal point in the industrial arts laboratory to stimulate learning. Display spaces should abound in this area.

*Is the laboratory acoustically treated?* Not only should the ceilings be treated with sound absorption material, but vibrating-type machines wherever possible should have sound-absorbing material located between the base of the machine and the floor.

*Are tool panels conveniently located?* Storing common tools near where they are used most often keeps unnecessary student movement about the laboratory at a minimum.

*Are bulky materials such as wood and metal stored near the receiving point in the laboratory?* Vertical storage areas are effective for lumber or metal because of the ease in handling long pieces, and often this method of storing conserves space.

*Are there adequate storage spaces for students' projects and experimental work?* Consider the storage space needs for other groups using the facilities, such as adult recreational classes and youth clubs. Separate storage rooms for individual classes are often used.

*Is space for students' personal belongings adequate and convenient?* Individual master-keyed lockers under benches are an effective storage method used in many laboratories. Open shelving near the main entrance is also used.

*Can the laboratory be darkened for special instructional media?* Sometimes a special room or the planning center is used as an audiovisual area.

*Have an adequate exhaust and a dust-proof area been installed for finishing activities?* Special attention should be given to this space to retard the spread of fire.

*Is the darkroom located near the graphic arts and other visual communication activities?*

*Are the display facilities located in the laboratory and in the school building in prominent locations?* Exhibiting students' work in recessed lighted display cases near the laboratory and/or in school corridors provides an effective means to recognize outstanding students' work and to help inform the faculty and others about the learning activities of the department.

*Are toilet facilities nearby?* Both male and female facilities should be considered.

*Are aisles and space between machines adequate?* The areas directly in front of large tool panels and assembly areas for large construction pieces need adequate space too.

*Are the industrial arts department facilities located near other school departments with which they have close instructional relationships?*

The industrial arts department should be located on the outside section of the school complex near the science and home economics departments or other related departments.

*Are the number and type of physical facilities adequate for the school?* Arriving at the number and type of facilities for the industrial arts department is a complex problem. Some of the variables to consider are the total number of pupils in the school, class size, trends and enrollments, costs, and the depth and breadth of the instructional program. The school enrollment size usually is the major determiner.

*Is the overall space adequate for the main laboratory area?* Exclusive of auxiliary facilities, the trend in recent years is toward increasing the square foot areas of industrial arts laboratories. Examples of auxiliary space not included in the main laboratory are finishing rooms, separate classrooms, and storage rooms.

*Is the shape and height of the laboratory adequate?* Although research reports recommend the shape to be 1:1½ to 1:2 and the ceiling height from 12 to 14 feet, experimentation with new shapes to meet emerging subject areas has merit too.

*Are the instructional aspects of the laboratories (internal or external) functionally related?* Consider the location of subject areas which have similar learning activities close to one another, such as electricity/electronics and power mechanics.

*Is the construction of the floors and floor surfaces adequate for the kinds of instructional activities in that area of the laboratory?* Subflooring is necessary for anchoring and supporting heavy machinery. Floor drains are desirable and a water hose connection should be located nearby.

*Are the walls made of material which can be easily cleaned?*

*Are adequate electrical and other services provided?* Emergency disconnect switches should be installed in several strategic areas. Research reports suggest that 220-440 volt three-phase and 110-120 volt single-phase grounded systems should be installed to meet power requirements of the industrial arts laboratory.

*Is adequate lighting provided?* Studies relating to this problem recommend fluorescent lighting from 50 to 60 foot-candles of light at the bench height. Color conditioning of walls and machinery is also recommended.

*Are environmental controls adequate?* Consideration must be given to injurious gases, fumes, and dust. Under-floor exhaust systems are recommended for woodworking machinery. Air conditioning can provide clean and less humid air, resulting in reduced equipment maintenance and replacement costs.

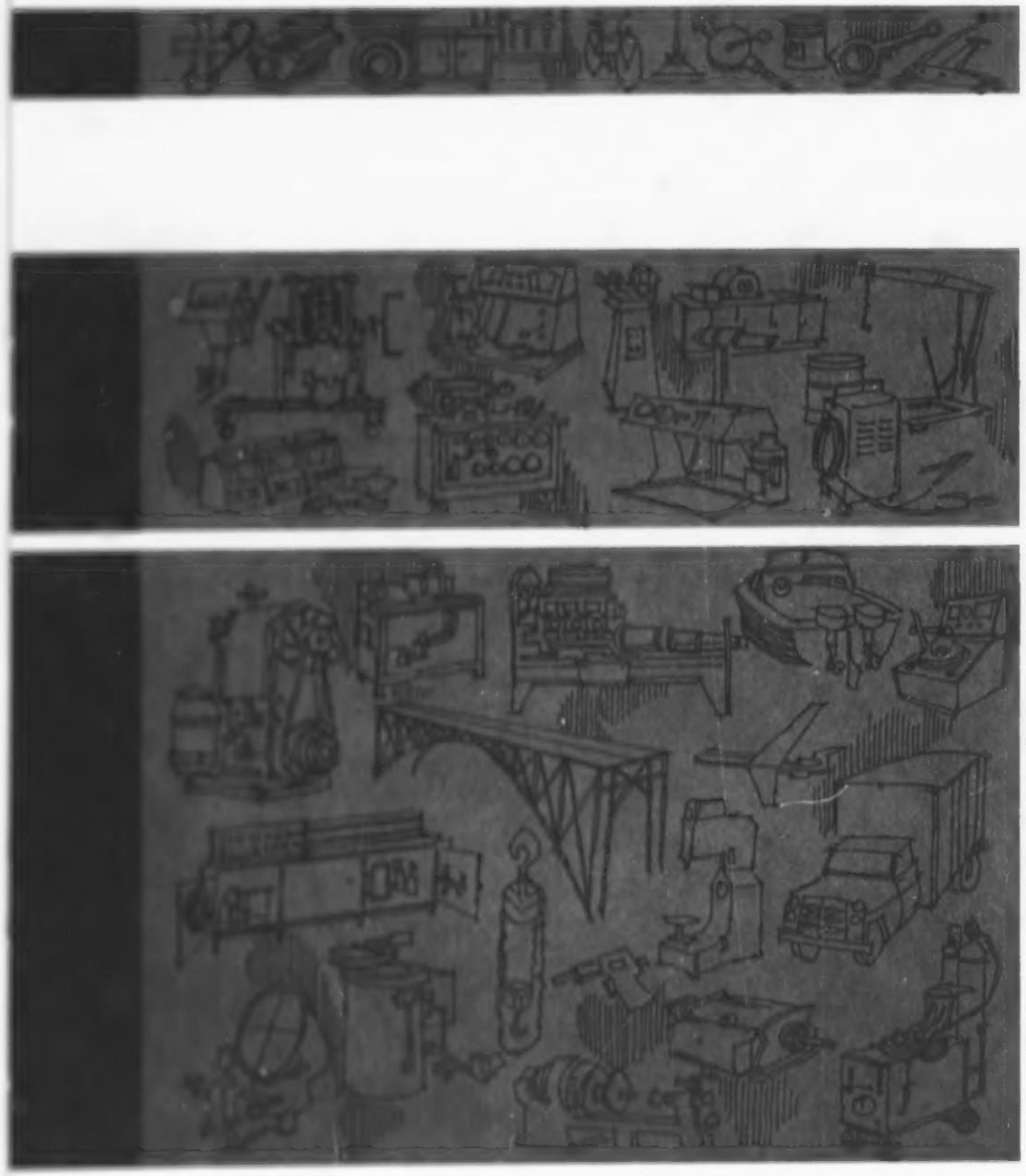
*Have sufficient safety and health precautions been taken?* Use the checklist provided in the previous chapter to evaluate this aspect of the plan.

## Recommendations for Improving Industrial Arts Education

This study highlights the interrelationship of philosophy and actual practice. The purpose of an industrial arts program is often reflected more in the physical setting (tools, machines, and benches) than in a well-written philosophical statement and set of objectives. This is sometimes dramatically shown when a laboratory is first built because the facilities play such an important part in implementing a philosophy. A stated philosophy and objectives are not enough; the topics, units of instruction, and ideas to be taught must be clearly identified so that they can be translated into a physical setting by the planners. However, such identification is a difficult task, and it takes a well-trained specialist knowledgeable in the field of industrial arts to do it.

Since individual teachers generally have the major responsibility for determining the instructional program in a school, teacher education institutions should place more emphasis upon the development of educational specifications and their relationship to facilities to carry out the philosophy of the program. Each prospective teacher should have the experience of writing educational specifications and designing and planning functional facilities to implement the educational specifications. Rigorous evaluations should be made of each prospective teacher's plan.

| TIME | TOPIC, COURSE, CONCEPT, OR UNIT OF INSTRUCTION | SCHOOL LEVEL | METHOD OF INSTRUCTION | SELECTED TYPES OF SPECIFIC EQUIPMENT AND SUPPLIES |
|---|---|---|---|---|
| PAST | AUTO MECHANICS | ELEMENTARY—NOT TAUGHT<br>JUNIOR HIGH—NOT TAUGHT<br>SENIOR HIGH | Lecture • Reference manuals<br>Individual sequential tasks | Engines • Hand tools • Storage room<br>Chassis • Hydraulic lift • Valve grinder |
| PRESENT | POWER MECHANICS | ELEMENTARY—NOT TAUGHT<br>JUNIOR HIGH<br>SENIOR HIGH | Lecture • Library<br>Individual sequential tasks<br>Group tasks • Mock-ups<br>Visitation to industry | Exhaust hoods • Small piston engines<br>Small engine dynamometer • Solid fuel rocket<br>Thermoelectric generator<br>Exhaust hoods • Test dynamometer<br>Solid fuel rocket • Engine analyzer<br>Pulse jet with exhaust reflector |
| FUTURE | POWER AND/OR TRANSPORTATION | ELEMENTARY<br>JUNIOR HIGH<br>SENIOR HIGH | Individual and group instruction<br>Research and experimentation<br>Models • Visits • Resource center<br>Mass or line production<br>Programed instruction<br>Computer-assisted instruction<br>Television | Work surfaces • Small hand tools<br>Storage cabinet • Saw horse • Portable workbench<br>Model piston-type engines • Model steam engine<br>Model rockets • Model rocket launcher<br>Metal and wood hand tools • Drill press<br>Small engine dynamometer • Small piston engine<br>Thermoelectric generator • Engine test analyzer<br>Cabinets • Electric-heated steam engine<br>Rotary combustion engine • Solid fuel rocket<br>Cabinets • Work surfaces • Exhaust hoods<br>Ram jet engines • Solid fuel rocket<br>Wind tunnel • Fluid power test stand<br>Engine test stands • Loft for boat<br>Tensile strength machine • Thermoelectric generator<br>Bridge construction model |



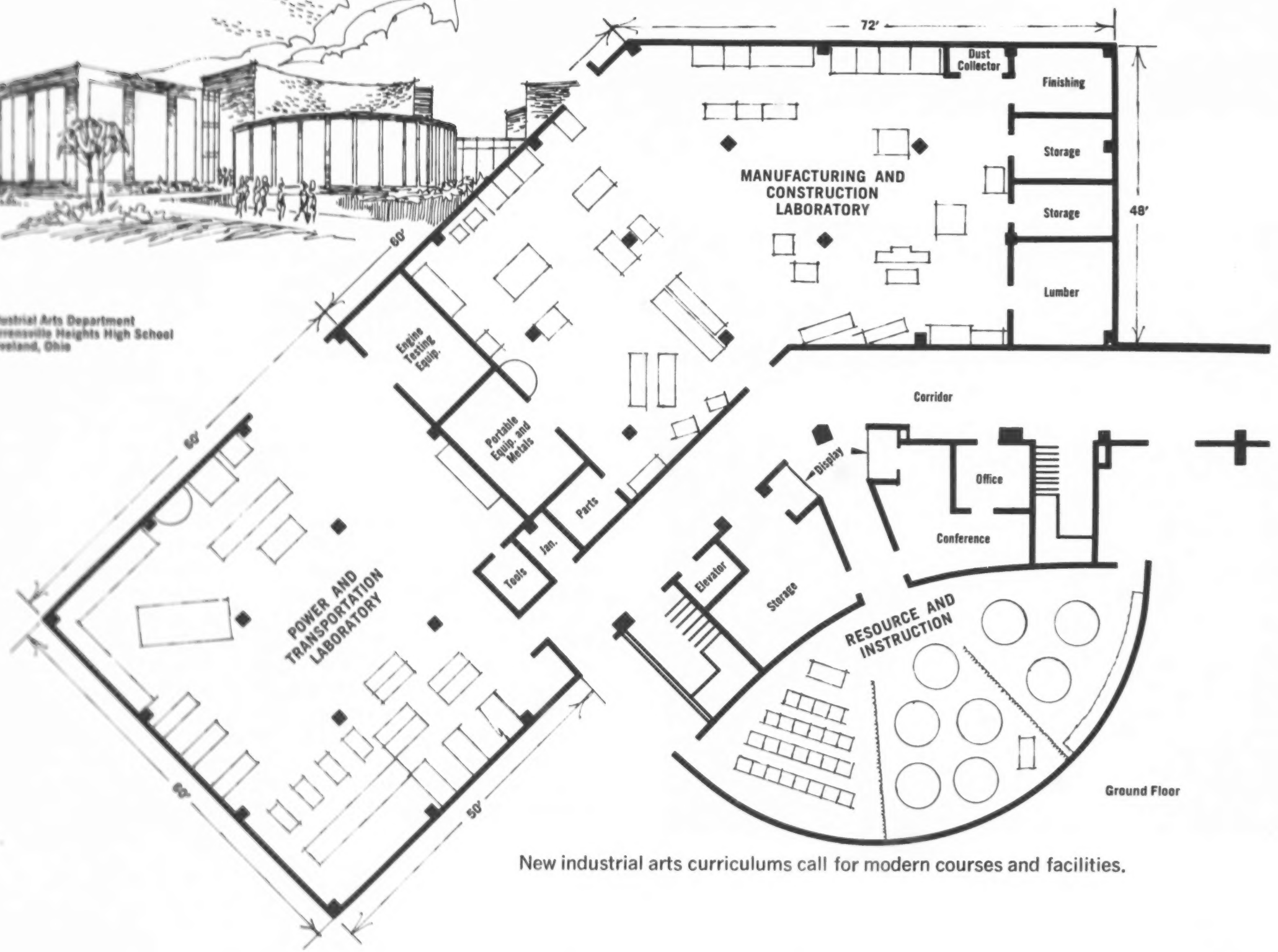
**Changing curriculum concepts influence instruction, equipment, and space needs.**

If an individual industrial arts teacher, school district, or State department of education sees industrial arts education as a phase of general education which (1) contributes significantly to students' understanding of industry and technology, (2) helps students identify and develop their innate technological talents, and (3) strengthens their academic studies, then the curriculum and facilities should take on the forward-thinking outlook of the industrial arts profession. Industrial arts should build from its present structure and broaden its offerings to reflect man's technological effort to improve his life and to control and modify his environment to suit his needs. Even the name *industrial arts* reflects this interrelationship. The term *industrial* means industry and technology; the term *arts,* creative. Together the terms suggest that man is using his creative abilities to modify technologically materials to increase their value in meeting his needs and wants. A good industrial arts education program should reflect this interaction of man's control over his environment. Industrial arts can be as viable, as dynamic as man is in his efforts to create language and mathematics, or to discover scientific truths.

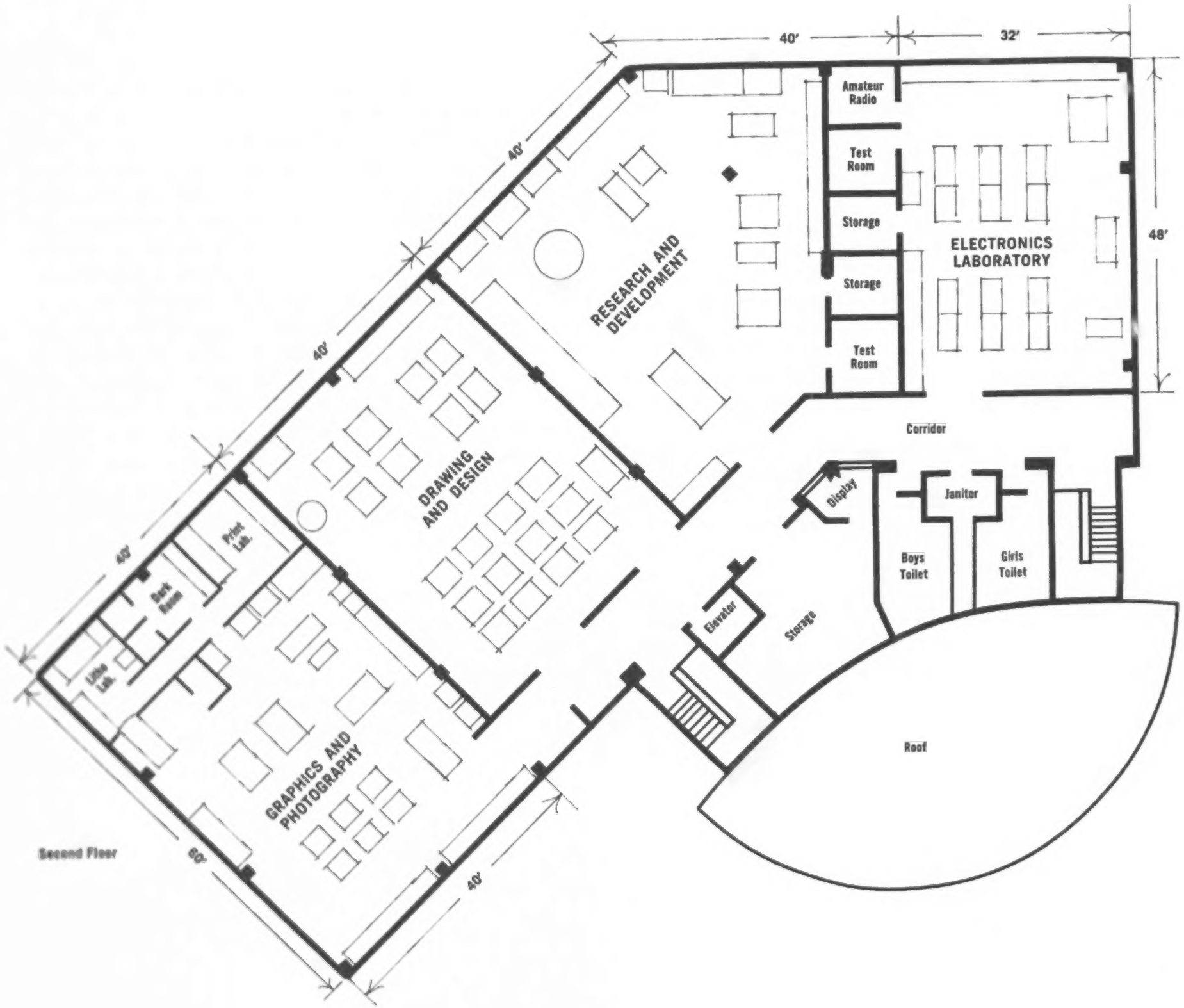
The industrial arts curriculum over the years has reflected this forward thinking. The current division of content of *power mechanics* is a good example. This term is used to indicate a subject, course, or topic within a course. Nevertheless, power mechanics traditionally stems from the narrower concept of auto mechanics. The industrial arts philosophy and new direction, however, have produced changes in the course which reflect the study not only of the automobile and its impact on society but also of other power units as energy-using devices, including mechanisms which transmit power—hence the term power mechanics.

However, the newer "cutting edge" philosophy forecasts an even broader concept of this course. The term *transportation* or *power and transportation* is emerging, which reflects a study not only of the automobile and other land vehicles from

Industrial Arts Department
Warrensville Heights High School
Cleveland, Ohio




New industrial arts curriculums call for modern courses and facilities.


40'
32'
40'
40'
40'
48'
Amateur Radio
Test Room
Storage
Storage
Test Room
ELECTRONICS LABORATORY
RESEARCH AND DEVELOPMENT
DRAWING AND DESIGN
Corridor
Display
Janitor
Boys Toilet
Girls Toilet
Elevator
Storage
Roof
Print Lab.
Dark Room
Litho Lab.
GRAPHICS AND PHOTOGRAPHY
Second Floor
60'
40'

a technological viewpoint but also of other modes of transportation, such as the airplane, space vehicles, and ships which operate upon and beneath the sea. This latter category—oceanographic vehicles—is just beginning to capture the imagination of some industrial arts teachers as a unit for study and experimentation.

Each topic, unit of instruction, concept, or idea has implications for the physical setting. The sketch shows the flow of ideas generated from the main topic and the impact it has on curriculum development and facilities. Notice that the narrow concept of auto mechanics did not influence the elementary or junior high school curriculums; however, the broader concept of transportation is reflected from kindergarten through grade 12 and has many more implications for curriculum and facilities.

Other industrial arts subject areas or divisions of content have had their narrow atomistic approach gradually changed to a broader concept reflecting the "new look" in the industrial arts curriculum. For example, woods, and metals have been broadened under the concept of manufacturing and/or construction; printing broadened to graphic arts and perhaps combined with electricity/electronics into the concept of communications. This broadening concept of the curriculum is also illustrated in the recent publication of the National Aeronautics and Space Administration entitled *Space Resources for the High School—Industrial Arts Resource Units.*

One of the most important and difficult tasks for the curriculum planner is the development of a workable course or curriculum. This is essential to the development of a functional industrial arts laboratory. Each State should have an active industrial arts curriculum committee to advise the State supervisor of industrial arts and to produce a State curriculum guide which identifies the instructional content. A published State curriculum guide can provide guidance for the main thrust of the curriculum and can help clarify the role of industrial arts in the total education program of the State. The State guide should be suggestive, give direction, yet allow for creative curriculum development by an individual school. This curriculum guide can also provide the State with criteria for making evaluations on programs and can also be helpful in determining future needs based upon factual data derived from the present offerings. Thus the State guide becomes a useful tool for strengthening the curriculum and should be continuously updated and published at least every 5 years.

Whether or not future programs take on some of the newer characteristics depends upon many factors, especially the undergraduate preparation programs, research, supervision, and effective inservice or retraining institutes. The curriculum movement in industrial arts education is not unlike the changes taking place in mathematics and science instruction.

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